POWER

Volume 63 New York, March 2, 1926 *No.* 9

What Does Supernatural Mean?

EXCEPT, perhaps, perpetual motion, there was nothing that Science at one time declared with more emphasis to be impossible than the transmutation of metals.

Now reputable physicists in three different countries claim to have done it.

Whether they have or not, there seems to be no reason why it should not and will not be done, for everything is said to be made up of the same kind of electrons and protons, and the chemical and physical differences of the so-called "elements" to be due to the number and disposition of such similar electrons and protons in their several atoms.

So the seemingly impossible has been brought about, not through necromancy and the exercise of the black art, but through natural, understandable, if not simple, operations.

And yet if one of those old alchemists had been wise or lucky enough to have stumbled upon this process, and anybody peering into his laboratory and seeing the ghastly glow of the mercury vapor lamp knew that he was converting mercury to gold or lead to mercury, it would have needed no further proof to convict him of being a magician.

If a medium of fifty years ago had had the facilities of modern photography, chemistry, optics, electricity, telephony, wireless control of power as well as transmission of sound and pictures, he could have imbued the world with superstitions, to eradicate which would have taken generations of demonstration of the normalcy and naturalness of the manifestations that produced them.

A few years ago it would have been a miracle to hear the utterances of one departed, in his own voice and with his own inflexion.

Only by a miracle could one have expected to sit in his home in America and converse with a friend in London.

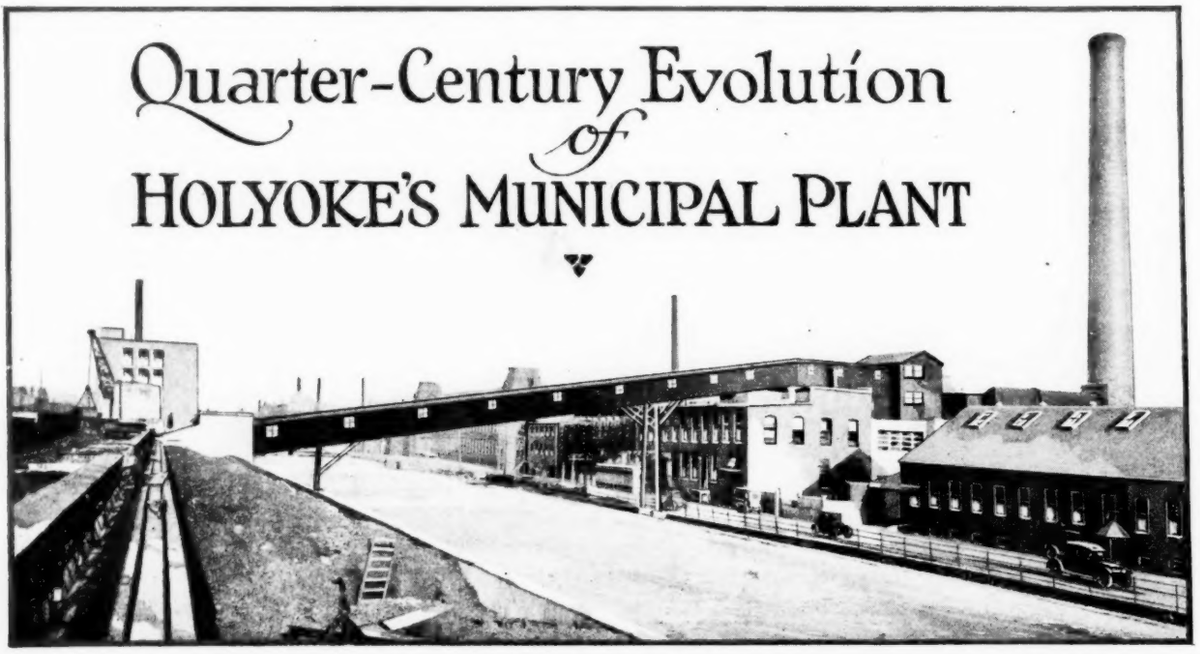
The presence in New York within an hour of an accurate photograph of an occurrence in San Francisco could be expected only by the interposition of supernatural power.

Yet we are seeing and doing all of these and more, and thinking nothing about it.

Where then does the normal, the natural, leave off and the supernormal, the supernatural, begin?

F. R. Low

Quarter-Century Evolution of HOLYOKE'S MUNICIPAL PLANT



Conveyor bridging first-level canal brings coal from pocket to overhead bunkers of boiler room

WHEN first taken over by the City of Holyoke (Mass.) in 1902, the municipal generating station had 273 customers and a peak load of approximately 400 kw. With steadily mounting load the station has passed by progressive steps from belted waterwheels, Corliss engines, antiquated bipolar and arc-light generators and vertical fire-tube boilers to modern stoker-fired water-tube boilers, 5,000-kva. and 10,000-kva. generating units, duplex drive for auxiliaries and modern coal-handling equipment, etc. Today this plant supplies 15,954 customers in addition to lighting the streets of Holyoke. The revamping, which is still in progress, involves extensive use of fusion welding. Data on income and expense and on contract prices of important equipment are included in the article.

RESTING snugly in an elbow of the Connecticut River, the City of Holyoke, Mass., was long ago placed on the power map by the construction of a dam and series of power canals conducting water to the wheels of numerous paper and textile mills. At present there are three levels of canals. These were constructed by the Holyoke Water Power Company, which sells water on a yearly power basis to the mills and also generates electricity in its own hydraulic and steam plants for sale in blocks exceeding 100 horsepower.

Street and domestic lighting, as well as a considerable portion of the industrial load, are supplied by a municipal combined hydro- and steam-electric plant between the first and second-level canals and about half a mile from the City Hall. This plant, originally operated by the Holyoke Water Power Co., was taken over by the City of Holyoke in 1902 along with a gas manufacturing plant and the entire distribution systems of both plants.

At that time the "prime movers" in the generating station consisted of four 265-hp. McCormick vertical waterwheels and two 400-hp. Wheelock non-condensing Corliss engines. Through gears, belts, clutches and jack shafts these transmitted their power to sixteen 50-light Schuyler series arc-light machines, one 100-kw. single-phase 133-cycle 1,100-volt Thomson-Houston generator and one 100-kw. 500-volt direct-current Edison bipolar machine. With its maze of belts and shafting the basement of the plant resembled an old-time machine shop.

The boiler plant contained five vertical fire-tube boilers—hand fired, of course. At the time of the purchase the plant had 273 customers and a peak load of about 400 kw. Today there are 15,954 customers and the peak load is around 7,600 kw. This remarkable growth has been paralleled by the evolution of the plant itself.

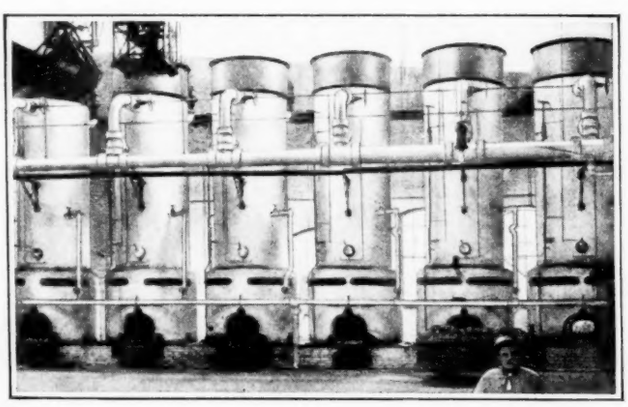
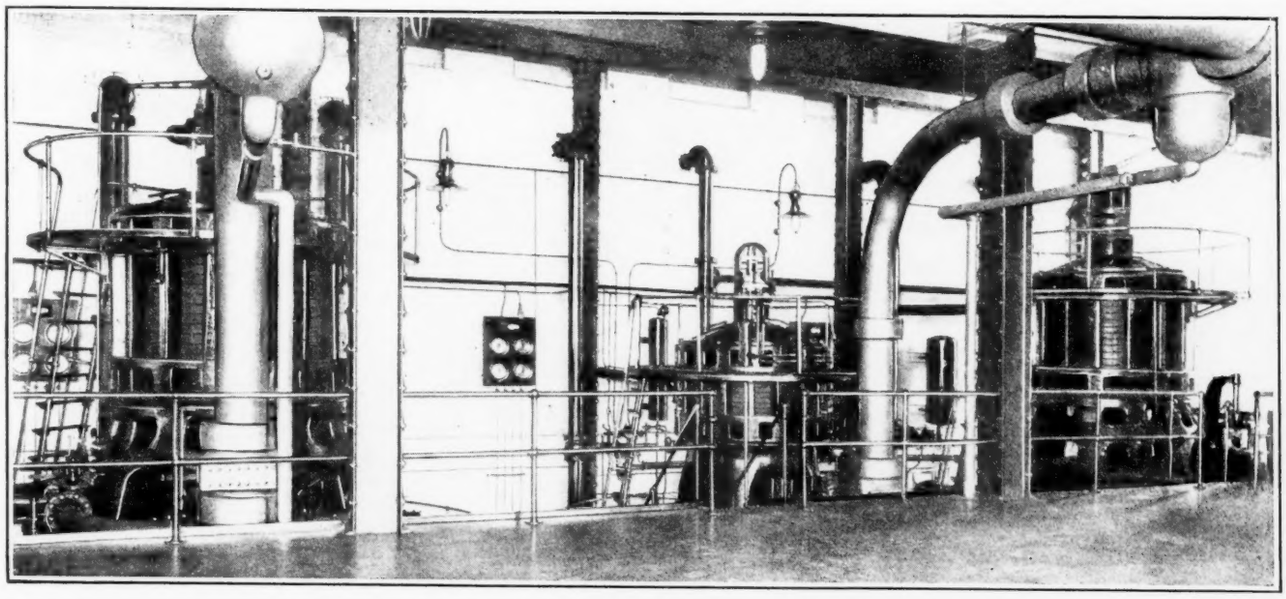


Fig. 1—Vertical fire-tube boilers used in the early days

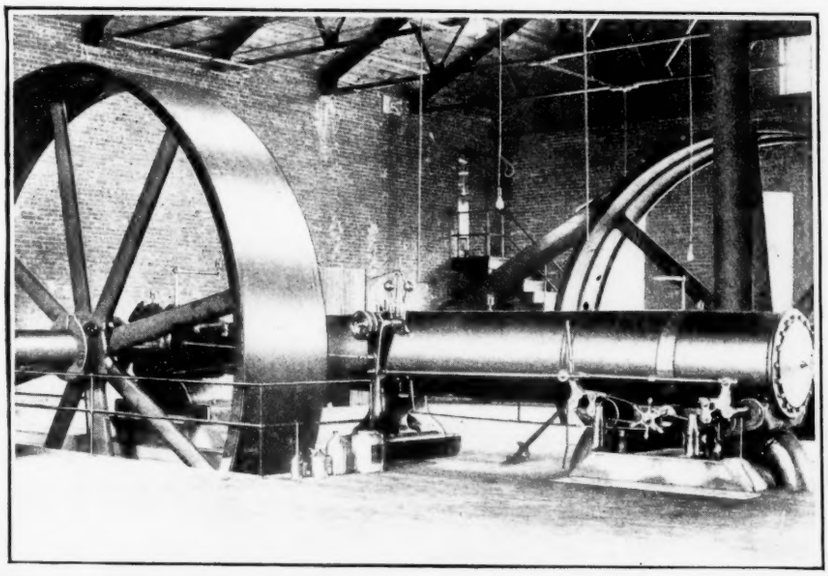


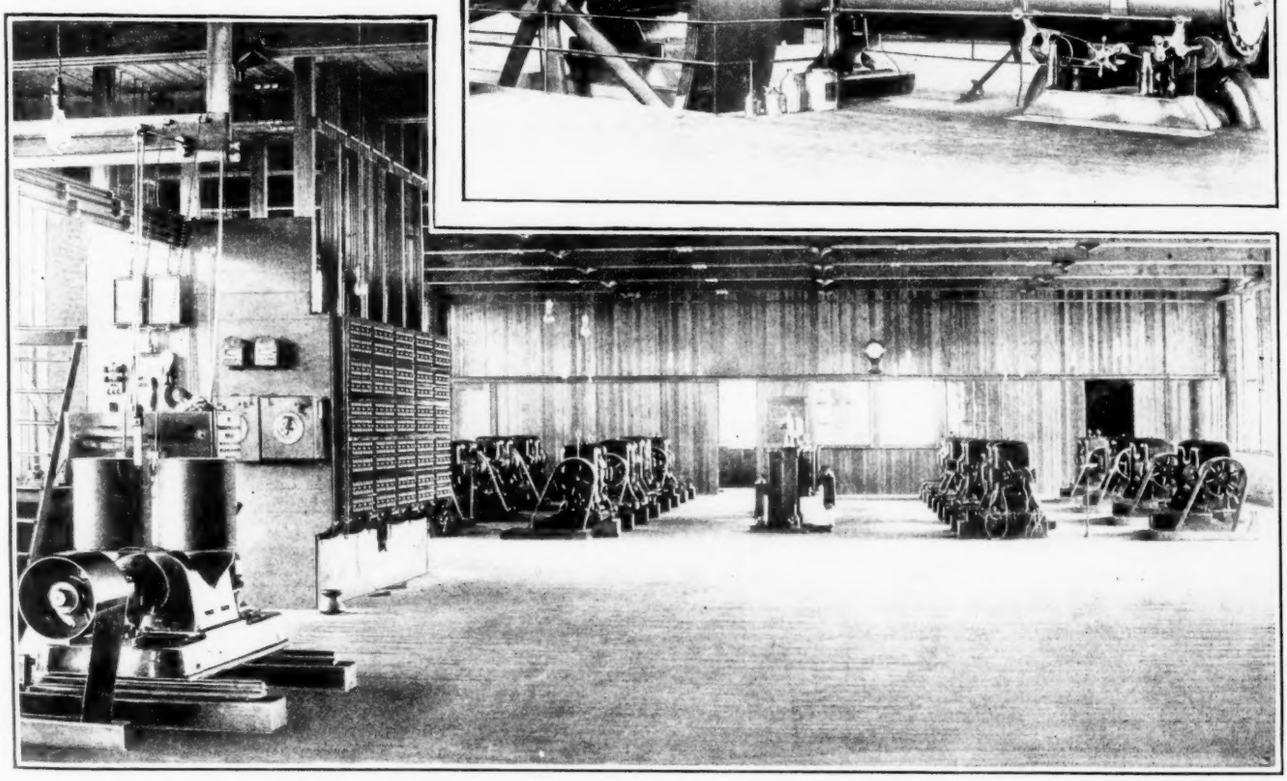
Old Timers

Fig. 2 (above)—Vertical turbo generators purchased in 1905, 1906 and 1907

Fig. 3 (right)—Wheelock non-condensing engine, removed in 1908

Fig. 4 (below)—Generating room when taken over in 1902





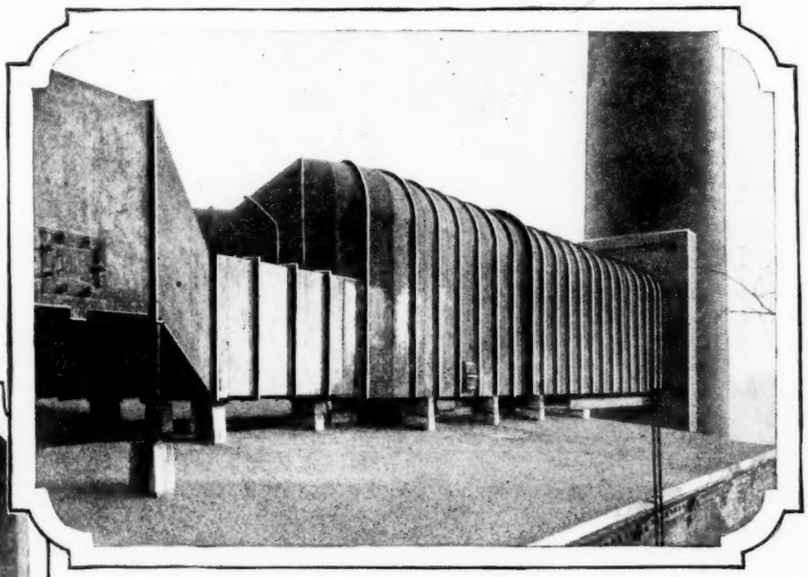


Fig. 5 (right) — Section of new breeching. The entire breeching, including a longer section (not shown) is built with accordion folds to take care of expansion, and is fabricated by fusion welding

Fig. 6 (below)—Modern hydraulic turbines installed in 1923 utilize head between first-level and second-level canals

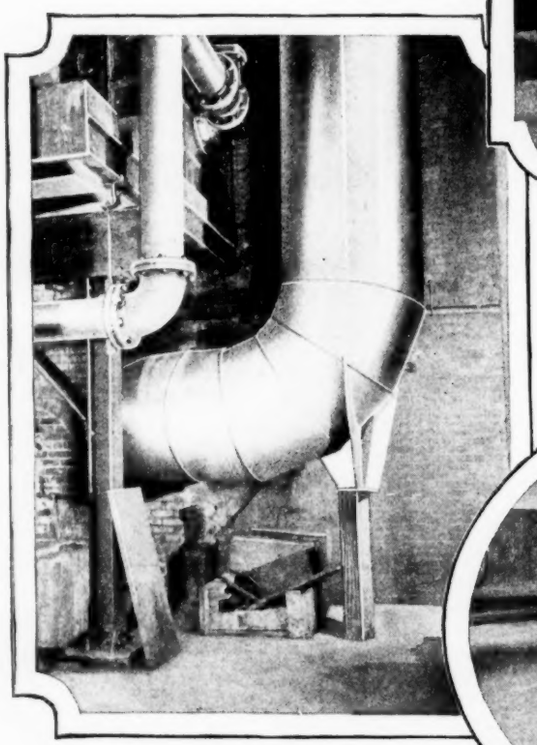
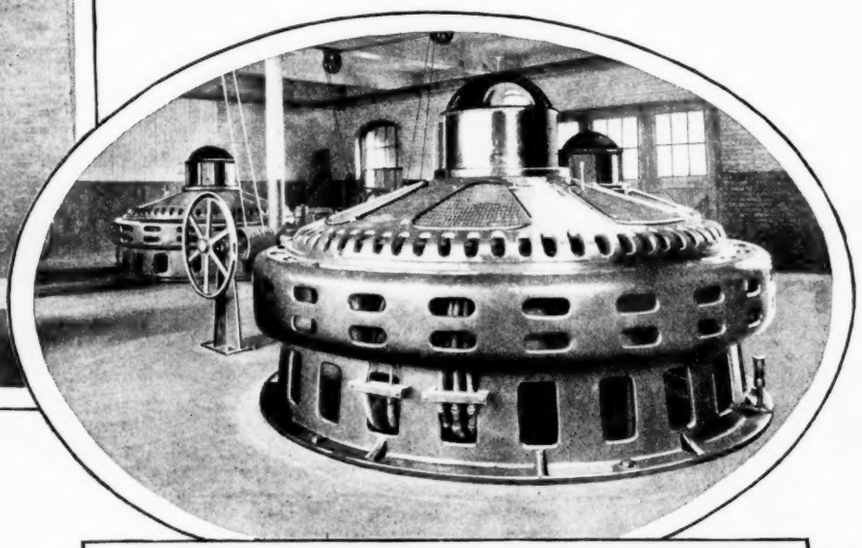


Fig. 7 (above) — Atmospheric relief pipe fabricated locally by fusion welding



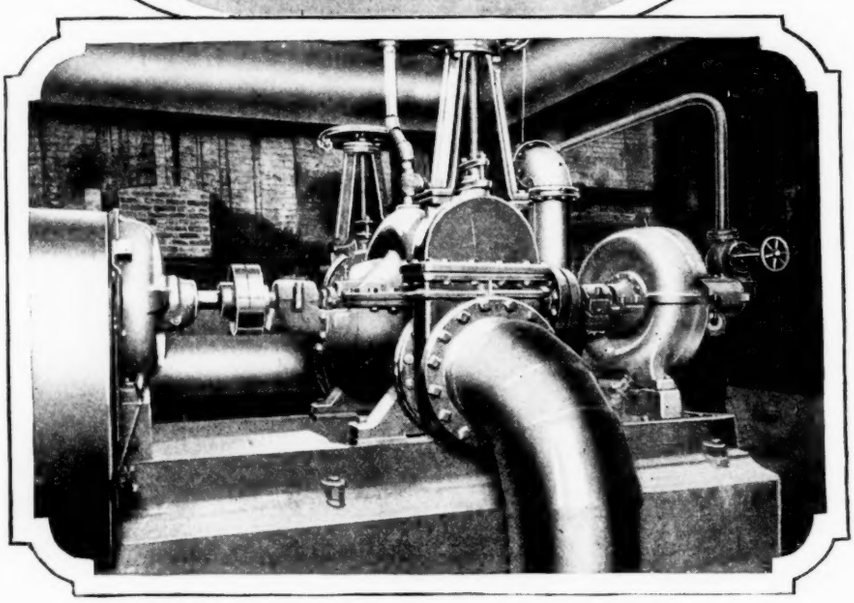


Fig. 8 (right)—Duplex driven circulating pump. Pump intake and discharge lines fabricated by fusion welding, which has been extensively used in new construction

A brief outline of this development is of historical interest.

In 1903 all the original generators were discarded, their place being taken by two 350-kw. three-phase 60-cycle generators belted to the waterwheel jackshaft. This innovation necessitated changing over all the series arc lights and replacing customers' direct-current motors by alternating-current machines. These changes

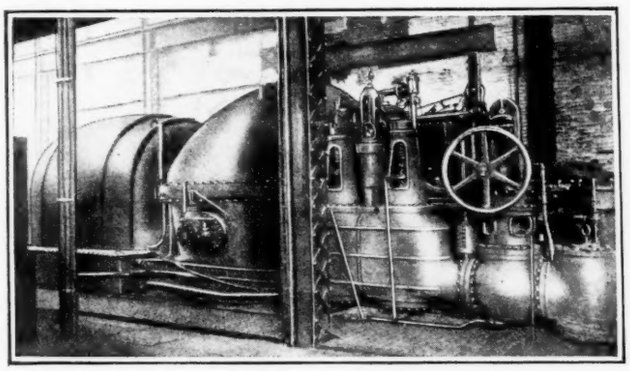


Fig. 9—Latest generating unit (10,000 kva.) will soon be ready for operation

were made at the expense of the Gas and Electric Department.

A year or two later another alternating-current generator, of 450 kw., was installed and belted to the waterwheel jackshaft. The growing load again caught up with the capacity in 1905, leading to the installation in that year of a 500-kw. vertical Curtis-type steam turbo-generator. Before this installation was completed, it became necessary to order a similar unit of 1,000-kw. capacity. This was installed in 1906. Six more of the vertical fire-tube boilers were purchased to handle the increased load.

In 1907 continued growth made the remodeling of the station imperative. The old generating building was reconstructed as an up-to-date turbine room, and the vertical units already mentioned were reinstalled there, along with the first of four 2,500-kw. vertical units for which space was provided. With the rapid advance in the art of turbine design and the development of horizontal units two of the other three projected vertical units were never installed. The last of the reciprocating engines was discarded in 1908.

With the construction of the new turbine room four 4,000-sq.ft. water-tube boilers with overfeed stokers were installed, together with an overhead telpher system for handling coal and ashes. In 1910 four more boilers of the same type and one more vertical turbine (the last of this type to be installed) were put in.

No further changes of importance were made until 1915, when two horizontal units, one 5,000-kva. and one 1,250-kva., were installed, the latter replacing the 500-kw. vertical unit.

The latest series of extensive changes was started in 1922 and is now nearly complete. The first step was to install two 7,000-sq.ft. water-tube boilers with underfeed stokers to replace the vertical fire-tube boilers. Next, the eight original water-tube boilers were replaced by four more of the new type. The present boiler room contains six 7,000-sq.ft. water-tube boilers equipped with 7-retort underfeed stokers, superheaters, soot blowers, forced-draft fans and air-flow steam-flow meters.

As the latest important addition to the plant a 10,000-kva. turbine has been installed along with complete new switching equipment, surface condenser with dual-drive auxiliaries and a twin strainer on the circulating water. The station steam rate should be greatly improved by the starting up of the new unit and auxiliaries and also by changes in the steam conditions. The pressure will be increased from 175 lb. to 225 lb. and the superheat from 100 deg. to 150 deg.

Another substantial improvement, from the point of view of operating reliability, is the provision of greatly increased coal storage. In 1924 a concrete coal pocket of 12,000 tons capacity was built on a tract of purchased land across the first-level canal. An electrically operated locomotive crane carries coal from the pocket to a crusher from which it is carried by a belt across the canal to the top of the boiler room. A cross conveyor (100-ton per hour) distributes the coal to the overhead bunkers. Coal may also be dumped direct from railroad cars to the crusher hopper to avoid rehandling.

Ashes are handled by handcars and skip hoist to an overhead hopper from which trucks are loaded. The new steam-plant equipment includes a 225-ft. brick stack of 12-ft. internal diameter and a modern type of outside breeching. Fabricated by welding, this is constructed with folds like an accordion to take care of expansion. Welding has also been extensively used with considerable saving in the fabrication of atmospheric relief piping, circulating water piping, high-pressure header nozzles, etc.

This latest revamping of the station has been ex-

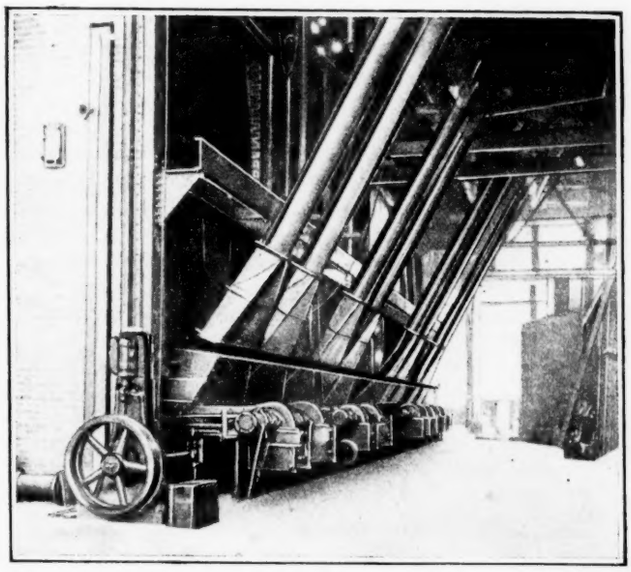


Fig. 10—Modern stoker-fired boilers bear little resemblance to original hand-fired, vertical, fire-tube units shown in Fig. 1

tended to include the adjoining water-power plant, which generates about 20 per cent of the total sent out. In 1923 the original McCormick wheels were replaced by four modern vertical generating units, two of 300 kw. and two of 350 kw. This change permitted the removal of all belts and shafting from the engine-room basement, leaving ample room for the condenser and auxiliaries of the new 10,000-kva. generating unit.

Being generally available for public inspection, the financial reports of municipally owned plants are a

valuable source of engineering information. The information given in Table I is condensed from more complete data given in the annual report of the Gas and Electric Department and covers the year ended Nov. 30, 1925. The figure given for current generated

TABLE I—OUTPUT COAL CONSUMED, ETC., FOR YEAR ENDING NOV. 30, 1925

Current generated, kw.hr	*21,981,200
Current purchased, kw.hr	2,005,502
Current sent out, kw.hr	20,727,013
Steam coal used, tons of 2,000 lb	22,702

* Includes 5,825,000 kw.hr. generated by hydraulic units.

includes about 5,825,000 kw.-hr. generated by the hydroelectric plant. The purchased power was furnished by the Holyoke Water Power Company.

Table II is greatly abridged from the financial statement for the same year. It gives the totals for income and expense and some of the more interesting separate items. The figure given for net income is really the

TABLE II—CONDENSED STATEMENT OF INCOME AND EXPENSE

Income		
Total income		$751,224.75
Expense		
Coal	$158,799.80	
Wages (power production)	64,949.75	
Water-power rental	24,144.58	
Other manufacturing expense	13,469.09	
Total manufacturing expense		261,363.22
Electrical energy purchased		17,630.24
Distribution expense		71,393.11
Depreciation	$50,915.00	
Interest	42,089.60	
Office salaries	27,135.43	
Other general expense	30,720.54	
Total general expense		$150,860.57
Total expense		$501,247.14
Net income		$249,977.61

net profit for the year, since interest, depreciation and other overhead expense have been included in expense. During the year $66,000 was expended for the retirement of bonds. This is not included in expense.

TABLE III—CONTRACT PRICE (INSTALLED) OF PRINCIPAL EQUIPMENT PURCHASED SINCE 1922

Equipment	Purchased from	Total Price	Unit Cost	Per
One 10,000-kva. turbogenerator (not including foundation)	Westinghouse Elec. and Mfg. Co	$141,900	$14.19	kva.
Four 7,000-sq.ft. watertube boilers (without setting)	Edge Moor Iron Works	$58,100	$2.07	sq.ft.
One 13,000-sq.ft. condenser (not including foundation)	Worthington Pump and Machine Corp	$35,050	$2.70	sq.ft.
Four Elesco superheaters	Superheater Co	$11,380	$2,875	superheater
Four 7-retort stokers (including engine drive)	Riley Stoker Corp	$26,966	$6,741	stoker,
Concrete coal pocket (12,000 tons)	Ranger Construction Co	$137,593	$11.46	ton
Complete new switching equipment	Condit Electrical Mfg. Co	$56,189	.....	....
One 100-kw. exciter (dual drive)	Westinghouse Elec. & Mfg. Co	$5,250	$52.50	kw.
One 4-in. 3-stage Worthington feed pump with Westinghouse turbine drive	Westinghouse Elec. and Mfg. Co	$2,100	.....	....
Cookson open feed water heater	Bates Machine Co	$2,930	.....	....
Outside breeching	Connery and Co	$8,473	.....	....
One 30-in twin strainer	Elliott Co	$5,491	.....	....
Coal crushing and conveying machinery	Underwood Machinery Co	$16,722	.....	....
Brick chimney 225 ft. high and 12 ft. internal diam	Alphons Custodis Chimney Construction Co	$13,450	.....	....
Locomotive crane (elec.)	Ohio Locomotive Co	$11,115	.....	....
Two forced-draft fans	Westinghouse Elec. and Mfg. Co	$4,502	$2,251	fan
One air cooler for 10,000-kva. generator	Schutte and Koerting Co.	$3,564	$0.36	kva.

The contract prices of some of the principal items of equipment purchased since 1922 are given in Table III.

For one year only after being taken over by the city, the electric service operated at a loss. This deficit was later changed to a profit. After paying up its arrears, the Department has for two years shown a substantial profit after allowing for all direct charges and overhead expenses.

The original consumers rate of 18 cents per kilowatt-hour was reduced several times until it reached 6 cents in 1908. On June 1, 1925, the rate was cut to 5 cents. The city is billed for street lighting at the rate of 4 cents per kilowatt-hour, the Department owning and maintaining the distribution system, lights and equipment.

Since 1913 the Gas and Electric Department of the City of Holyoke has been managed by John J. Kirkpatrick. A. W. Darby has been superintendent of the generating station since it was purchased in 1902. W. H. Shaw is chief engineer of the station. Acknowledgment is made to these gentlemen for invaluable co-operation in getting together material for this article.

Waterwheel and Diesel Engine in Virginia Woolen Mill

THE combination of a water power and a steam plant is quite usual in the textile industry, but the Charlottesville, Va., Woolen Mill, although using a boiler for process steam, has found the Diesel engine

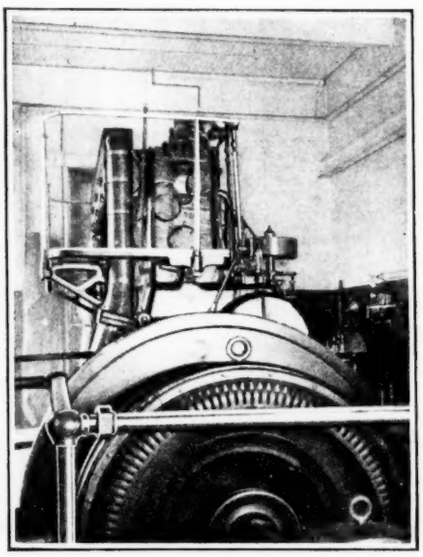


Fig. 1—Two hundred horsepower Diesel with direct-connected generator

operating in conjunction with its waterwheel a cheap source of power.

This mill now manufactures only blue and gray cadet cloth for uniforms, but originally it was built as a custom mill where, prior to the Civil War, the farmers came to have their wool carded. Being located on the Rivenna River, where a dam gives a 12-ft. head, power costs practically nothing. Fire destroyed the original structure in 1881, and a three-set spinning mill was erected soon after; later, it was extended into a five-set mill. Subsequently, a steam boiler was installed to supply hot water, and a 75-kw. alternator was belted to the 100-hp. waterwheel. To supply additional power, a transmission line was run from a small electric plant in the town.

In 1914 the water power was revamped and two

75-hp., 120-r.p.m. vertical wheels were installed. A 72-in. by 18-ft. boiler was provided for heating and hot water. The water supply was variable, and a 75-hp. semi-Diesel engine was added. One 75-kw. alternator was placed in the mill and belted to the oil engine, while the second generator was belted to the waterwheel.

In 1924 a new boiler plant containing a 72-in. by 18-ft. horizontal fire-tube boiler was built, and the 200-hp. vertical three-cylinder solid-injection Diesel shown in Fig. 1 was added to carry most of the load during periods of low water. This engine is direct connected to a 100-kva. three-phase 60-cycle 2,300-volt alternator with a direct-connected exciter.

The manner in which the wheels and the engine are tied together is shown in Fig. 3. The two wheels *A* and *B* are in separate housings. Ordinarily, the coupling *C* is loosened and wheel *A* drives the shaft *G*, which in turn serves a number of machines on the first floor and drives the 75-kva. alternator *D* used for lighting purposes at night. In addition, shaft *G* is belted to shaft *E*, which runs through the entire building. Wheel *B* drives the shaft *H*, serving several machines and also driving the mainshaft *E*. Belted to *E* is the alternator *F*. This machine usually operates as a synchronous motor, supplied with current from the 200-hp. oil-engine-driven generator located in a separate building about 200 ft. away.

The gates of wheel *B* are closed and the water power is obtained from wheel *A*. If this power is enough to pull the mill at the synchronous speed of the alternator

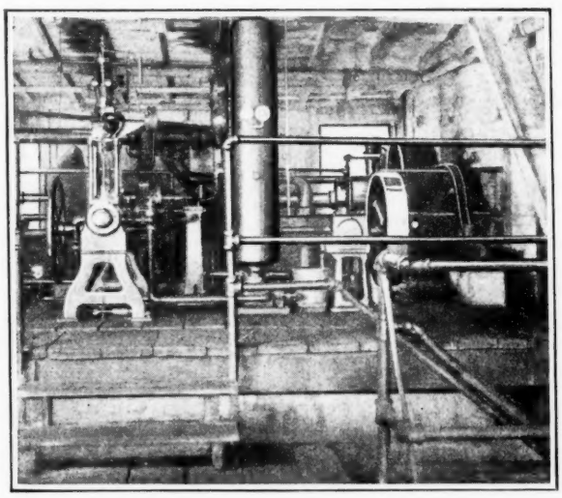


Fig. 2—Top of wheel housing, showing governors

F, this alternator simply floats on the line, drawing no current from the oil-engine-driven-generator save that required to magnetize the fields, and the oil engine supplies only the energy used by motors in the mill. When the load becomes heavier, the lineshaft speed drops slightly and the alternator *F* at once becomes a motor, drawing current from the oil-engine set and helping pull the mill load.

If for any reason the oil engine is shut down, the two wheels may or may not be coupled together, but in all events they both drive the mill's lineshafts. Either alternator *F* or *D* as may be desired, supplies the motor and lighting current.

The boiler supplies only the steam for heating and drying, and the hot water for dyeing. It was felt that the small amount of steam needed did not justify the use of a steam engine whose exhaust would be much greater than required at the mill. It was not feasible to install a bleeder turbine of 200-hp. capacity; the oil engine seemed the logical power and the arrangement has worked out quite economically.

The engine is in operation from 200 to 250 hours a month. The fuel consumption is close to 1 gallon per 11 kw.-hr. developed; Diesel oil with a gravity of 27 deg.

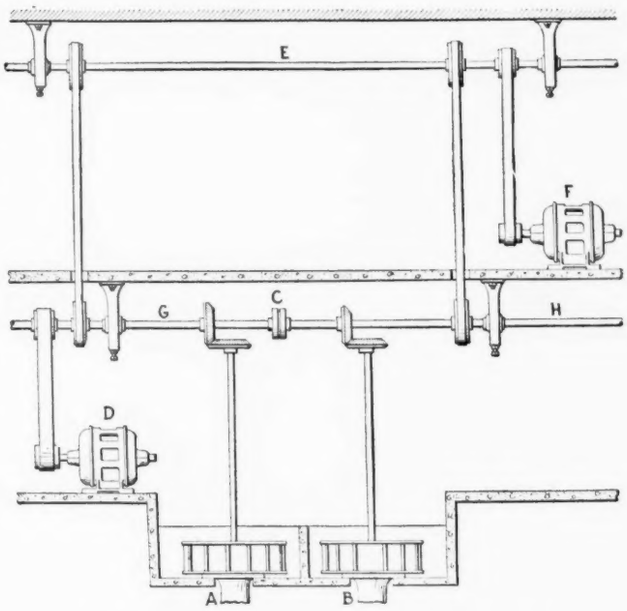


Fig. 3—Arrangement of balancing loads on waterwheel and engine

Baumé is purchased at 5½c. per gallon. The lubricating oil is reclaimed at the end of each month, and the system is then filled with new oil. During the next month the oil added is that reclaimed. The consumption of new oil averages 25 gal. a month, or approximately 1 gal. per 2,000 rated hp.-hr.

The boiler room is equipped with an open heater to which all the condensate returns, makeup being obtained from the city mains.

Measurement of Air Pump Suction Temperature

Measurement of the air-pump suction temperature is thought to be one of the most important observations necessary for analyzing condenser and air-pump performance; yet, in many cases, it is measured improperly. Common practice incorrectly prescribes the use of the ordinary well-type thermometers, and even test instruments placed in finned wells give wrong indications. The pipe temperature is more often read than the air-vapor mixture temperature.

Test practice at one station prescribes the use of an engraved thermometer inserted uncovered into the pump suction pipe through an air-tight rubber stopper bushing. Under such conditions the indicated temperature has been observed to fluctuate fractional degrees quite rapidly, indicating that accurate measurement is obtained. For an operating instrument the exposed-bulb, flue-gas type of thermometer serves well, if air-tight.—*Prime Movers Committee, N.E.L.A.*

Connecting Meters and Relays to Transformers

By J. B. GIBBS
Transformer Engineer, Westinghouse Electric & Manufacturing Company

SOME of the simpler and common connections for single-phase and polyphase circuits are given. The accuracy of instrument transformers and the factors that limit the number of meters and relays that can be connected to the same transformers are discussed.

IN MODERN power systems, with their high voltages or currents, or both, it is usual to find instrument transformers used with instruments and relays. The transformers protect the instruments and the operators from the system voltage, they make it possible to use small and inexpensive instruments, and they increase the accuracy of measurement and control.

Polarity Markers

Instrument transformers are always supplied with polarity markers on one of the high-voltage and on one of the low-voltage leads. The markers are usually white and vary with the type of transformer and with the manufacturer, from a simple spot of white paint to a porcelain button on or adjacent to the leads; or sometimes a white porcelain bushing is used on the marked lead and a brown or black bushing on the unmarked lead. The markers are placed on the leads so that when the current is flowing toward the transformer in the marked high-voltage lead, a corresponding current will be flowing away from the transformer in the marked low-voltage lead. In the diagrams the polarity markers are indicated by a dot on the leads. Both current and voltage transformer leads are marked in this way.

Fig. 1 shows an ammeter connected to a single-phase power line through a current transformer, and an ammeter *A* and relay *R* are shown connected to the same current transformer in Fig. 2. It should be noted that all the instruments and relays that are connected to the same current transformer are connected in series, so that the full current flows through each. The polarity markers are shown on the figures, but with instruments or relays that depend on current only for their operation, the polarity does not make any difference.

Fig. 3 shows a voltmeter connected to a single-phase high-voltage line by means of a voltage transformer. Fig. 4 shows a voltmeter and a frequency meter connected to the same voltage transformer. The various instruments that are connected to a voltage transformer are always connected in parallel, so that each gets the full voltage. With instruments such as these, which depend on voltage alone for their action, the polarity is not important. In general it may be said that instruments or relays that depend on only one quantity, either current or voltage, do not take any account of polarity; but instruments or relays that depend on both current and voltage must be connected with a proper regard for polarity.

For instance, Fig. 5 shows a wattmeter connected to a single-phase high-voltage line with both current and voltage transformers. If the polarity of one of the transformers is reversed the wattmeter will read backward. A reverse-current relay is another example of a device that must be connected with the proper polarity. Otherwise it will trip the circuit breaker under normal conditions instead of under abnormal conditions.

Measuring Power Consumption with a Single Meter

Sometimes a three-wire single-phase circuit is supplied to a customer and it is desired to measure the total power consumption with a single meter. The current in the middle wire of a three-wire system is the difference between the currents in the two outside wires. This is illustrated in Fig. 6, which shows ten amperes flowing in the top wire and 9 amperes in the bottom wire, leaving one ampere for the middle wire of the circuit. The power in this circuit might be measured by using two meters, one with its current coil in the top wire and its voltage coil between the top and the middle wires, and the other meter with its current coil in the bottom wire and its voltage coil between the middle and the bottom wires. We should then read on the first meter $115 \times 10 = 1{,}150$ watts and on the second meter $115 \times 9 = 1{,}035$ watts, where the voltage between the outside wires is 230 and between the outside and middle wires is 115 volts. The same result could be obtained by using a 3-wire current transformer as shown in Fig. 6. Each of the outside wires passes through one of the primary windings of the transformer. The current coil of the wattmeter is connected to the secondary of the current transformer, and the voltage coil is connected to one outside and the middle wire as shown. The reading will be $115 \times (10 + 9) = 2{,}185$ watts as before. This is a connection that is much used for customers who take large amounts of single-phase current. The three-wire current transformer, of course, may have any ratio desired and the meter reading will be multiplied by the corresponding constant.

Grouping the Instruments

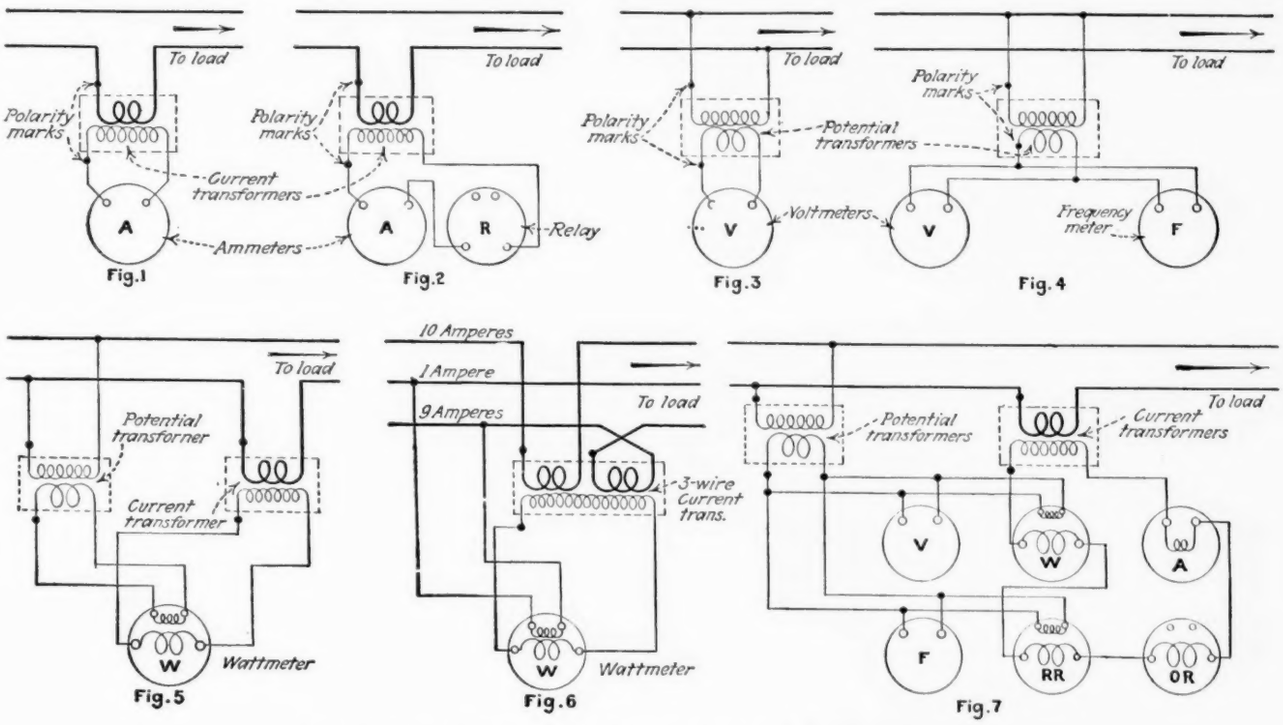
The same current and voltage transformers may carry a number of different instruments and relays, provided that the total burden[1] is not too great for the transformers. Fig. 7 shows a group consisting of voltmeter *V*, frequency meter *F*, wattmeter *W*, ammeter *A*, a reverse-current relay *RR*, and overload relay *OR*, all connected to the same transformers. This example shows

[1]The word "burden" has come into general use to apply to the load on the secondary of instrument transformers. This is to avoid confusing this quantity with the "load" on the power system.

how the current circuits of all the instruments are connected in series to the current transformer and the voltage circuits are connected in parallel to the voltage transformer.

Polyphase connections are the same in principle as the single-phase connections already shown. Two-phase circuits are usually treated as two single-phase circuits so far as meter and relay connections are concerned. Three-phase connections permit the use of certain wires that are common to the three phases. They, therefore, sometimes appear more complicated than the corresponding single-phase circuit, but the principle is the same.

Fig. 8 shows three ammeters connected to a three-phase circuit through three independent current transformers. Fig. 9 is a similar arrangement, but the three voltmeters to three-phase lines. Fig. 11 shows three voltmeters connected to three separate voltage transformers, one between each pair of lines. This is the same thing, electrically, as the delta connection, Fig. 12, except that the secondary circuits are interconnected in the latter. Fig. 13 simplifies this connection by omitting one of the voltage transformers. Since the voltage from A to B plus the voltage from B to C is equal to the voltage from A to C, the voltmeter connected between the two outside lines will read the voltage from A to C, with the proper multiplier. To make these sketches clear, three voltmeters are shown. In an actual installation, however, only one voltmeter probably would be supplied and a voltmeter switch would be used to connect it to any circuit desired. An am-



Figs. 1 to 7—Single-phase transformer and meter connections

current transformers are connected in star. With a three-phase, three-wire system the current flowing outward in a wire is balanced by the current flowing inward in the other two wires. The connection shown by the dotted lines, therefore, will not carry any current, and may just as well be omitted.

For the three-phase three-wire system the connections, Fig. 9, can be simplified still further. In such a system the current flowing outward at any instant in line B is the sum of the currents flowing inward at the same instant in lines A and C. If the current in line A can be added to that in line C, we shall have the current in line B. Connections for doing this are shown in Fig. 10. Ammeter A' carries the current from transformer A; ammeter C' carries the current from transformer C and ammeter B' carries the sum of the two, which is equal to the current in line B.[2]

Several different plans are available for connecting meter switch may also be used with the current transformers in Figs. 8, 9 and 10 so that a single ammeter may be connected in any one of the three lines.

A combination of meters and relays may be connected to the same set of transformers if the total burden is not beyond the capacity of the transformers. All the current coils of the various instruments and relays are connected in series to the current transformers, and all voltage coils are connected in parallel to the voltage transformers, paying due attention to phase and polarity in both cases.

The capacity of an instrument transformer is rather a hard thing to define because it depends not only on the burden on the transformer, but also on the accuracy desired. A voltage transformer, for example, is usually rated at 200 volt-amperes and compensated for some smaller burden, perhaps 40 volt-amperes. This means that it will give its best accuracy at 40 volt-amperes, and its ratio with a burden of 200 volt-amperes may have an error of, say, $\frac{1}{2}$ to $1\frac{1}{2}$ per cent. For ordinary use with voltmeters or relays such an error

[2]The current in B is really opposite to the vector sum of the currents A and C, but with ammeters the sign of B need not be considered.

as this would not be objectionable, but for use with watt-hour meters, which are used to measure the power sold to a customer, it would be too high. For such service the burden on the voltage transformer should not exceed the burden for which the transformer is compensated. Similarly, a current transformer may be rated at 50 volt-amperes and compensated for 25 volt-amperes. This same current transformer may be able to carry a burden of 150 volt-amperes if an error of 3 per cent to 4 per cent is permissible.

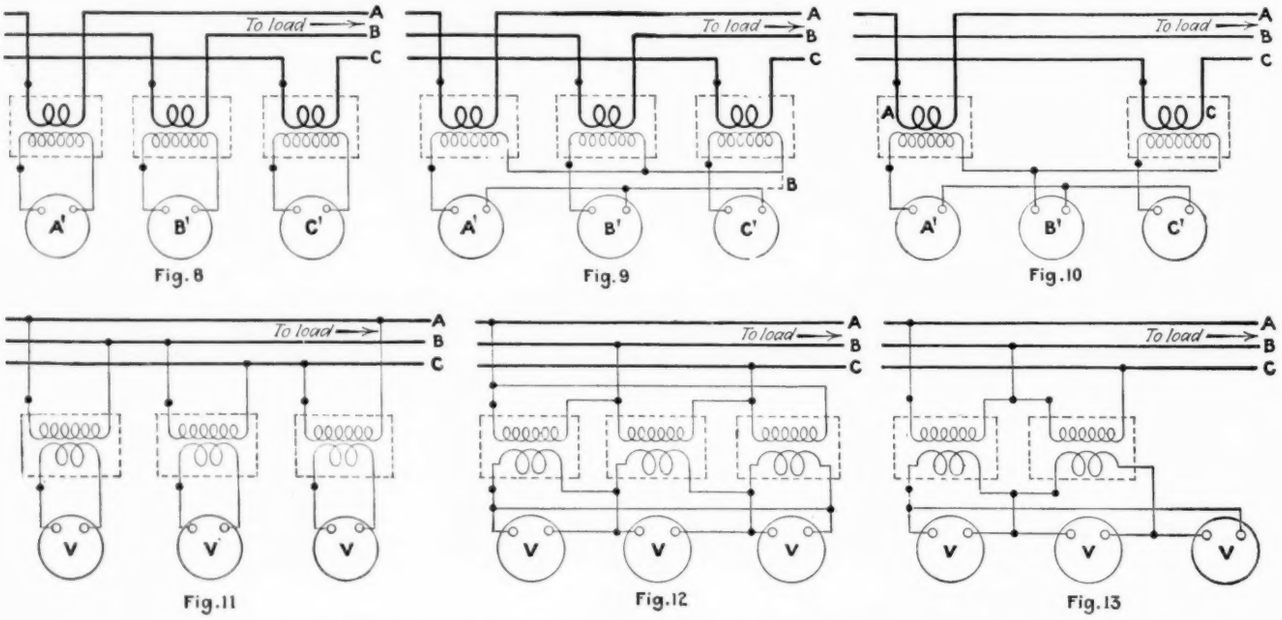
The necessary accuracy depends on the service to which the transformer is to be applied. For most relay work an accuracy within 5 per cent may be close enough; for indicating instruments it may be desirable to have an accuracy within 2 per cent, and for watt-hour meters, used for billing customers, perhaps the accuracy should be within ½ per cent. These figures are not to be regarded as established limits. They are mentioned merely to indicate the wide range of accuracies that may be used in various classes of work.

Sometimes the requirements conflict. For instance, the meters and relays on a certain circuit may constitute a heavy burden for the current transformers. At the same time it may be necessary to connect a watt-hour meter to the circuit. In such a case it is advisable to use two sets of current transformers, one for the watt-hour meter only, and the other for the other instruments and the relays. The same result can also be obtained by using double secondary current transformers. These are two separate and independent secondary windings, each mounted on its own separate core, but both assembled with the same primary coil. As compared with entirely separate transformers, this arrangement saves space, weight and cost, and in transformers for high voltages this saving may be considerable.

The type of instrument transformer to be used in a given connection, depends on the voltage of the circuit and on the preference of the engineer. For use indoors voltage transformers are made dry type, that is, without oil, up to 13,800 volts. For outdoor use, in these voltages, voltage transformers are usually made oil filled, but those for lower voltages are sometimes made gum filled. Above 13,800 volts, voltage transformers are always oil filled. The difference between the indoor and outdoor designs is in the bushings. Current transformers are regularly made dry type for circuits up to 25,000 volts, and oil filled for circuits of higher voltage, although in some cases the dry type is used for higher voltages. Outdoor dry-type current transformers are carefully insulated and mounted in weatherproof cases so as to keep them free from moisture. Oil-insulated current transformers are made for indoor or for outdoor use on circuits above 16,500 volts.

A special type of current transformer, which is sometimes useful, is the through type. This is, in effect, a current transformer with a single-turn primary winding. It consists of an iron circuit with the secondary winding on it and an opening through it for a busbar or cable which carries the current to be measured. The great advantage of this type is its mechanical strength. The mechanical stresses that are produced in the ordinary current transformer by short-circuits, are balanced in the through type within the transformer itself so that the transformer is safe from failure from this cause. The objection to this type is that its accuracy is good only if it has a fairly high ratio. If the ratio is 1,000 to 5 amperes or more, the performance is as good as that of a high-grade current transformer, but for lower ratios the performance is not so good, and it grows worse as the ratio is decreased. Such transformers are made for circuit-breaker tripping with ratios as low as 50 to 5 amperes, but through type transformers of such a ratio would not be suitable for instrument use.

For any circuit the problem is, first, to select the instruments and relays which are needed, and then to choose instrument transformers that will give the required degree of accuracy.



Figs. 8 to 13—Single-phase transformer and meter connections on a three-phase circuit

Adapting the Steam Turbine to the Industrial Power and Heating Load

By C. S. COGGESHALL*

THE author discusses the diversified demands of the industrial plant and describes a line of turbines which, like sectional filing cabinets, can be set up to meet almost any requirements.

THERE was a time when many industrial plant owners and executives considered the power house a necessary evil and an evil necessity. They were able to visualize the returns from new productive machinery and for this reason were ever ready to approve large investments in more efficient apparatus to produce the factory output, but it has been harder for them to appreciate that improvements in their power house and plant heat balance have an appreciable effect on the cost of their products.

In recent years, however, owing to the great amount of publicity given this matter by the large central stations, those who are engaged in the operation of industrial enterprises have developed a keener appreciation of the financial advantages to be gained through a careful study of the heat balance in the plant in its relation to power production.

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Such studies, under a variety of conditions, have given rise to a growing demand for steam turbines specially constructed to suit individual operating conditions. In the central-station field, while steam pressures vary widely, initial steam temperatures usually run close to 700 deg. F., and the exhaust pressure is almost invariably specified as one inch of mercury absolute for larger machines with somewhat higher values quoted at times for machines of small capacity. In the industrial field, on the contrary, there is hardly any connecting thread of consistency between operating conditions in different plants. Exhaust pressures vary widely, owing to the demands for heating steam for various industrial processes. In some cases steam is required at two or more pressures, and for this purpose the turbine must be arranged for steam extraction from appropriate stages.

Another detail in which the modern industrial demand is widely diversified is in the matter of governing. A turbine may be governed to maintain a constant pressure at one or more points of discharge of steam, it may be governed to maintain a constant load output, it may be governed for constant steam flow, or the like.

In order to meet the demands created by this diversification of operating conditions, the manufacturers of turbines have had to quote on machines built for special conditions. Appreciating the disadvantage of this arrangement and the great significance of the entire situation to the turbine business, the General Electric

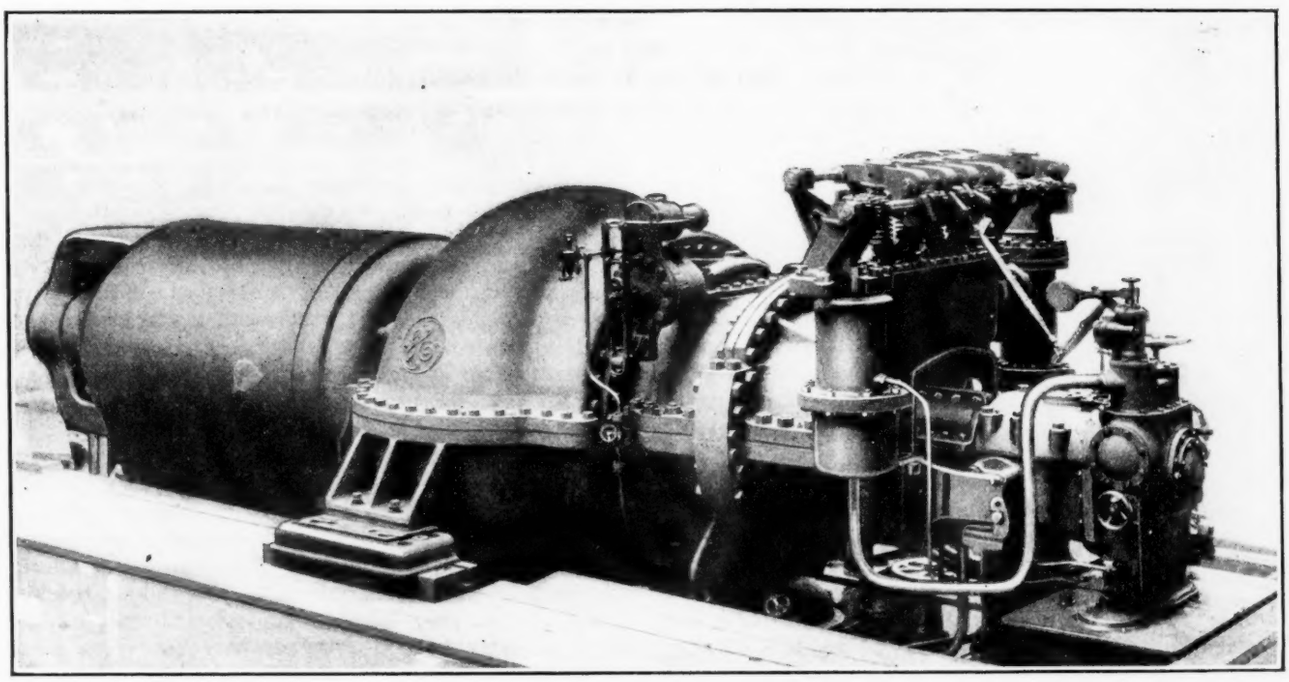


Fig. 1—This turbine, with one steam-extraction stage, is typical and indicates how operation has been facilitated by locating practically all adjustments within easy reach

Company some time ago designed an entirely new line of turbines whose flexibility is such that it is possible to meet a wide variation in steam conditions and load demands and to put together a turbine exactly adapted to the customers' needs.

In general the plan has been to design a series of turbine sections, which may be bolted together in various combinations, thus making it possible to build up machines of any desired characteristics. This has been accomplished only through a high degree of standardization and a careful design of components, together with an extensive shop equipment of special tools, jigs and the like. These preparations make possible interchangeable manufacture, moderate cost per unit and good shipping schedules.

To develop a clear idea of what has been accomplished by this new standardization of parts, a few of the types already produced will be described.

Several turbines have been produced for small central stations and municipalities where high economy with straight condensing operation is desired. In many of these plants one to three bleed points are provided for progressive feed-water heating.

A further large number of these machines has been installed in various central stations for house service. These vary from what is known as the "spinning" turbine, in which the machine is run at no load condensing until a disturbance on the main bus calls upon it to carry the essential auxiliaries, to units that are run continuously at maximum rating to take care of the feed-water heating system of the station. Some of these machines have been built non-condensing with extractions at two pressures for this purpose, and each of these extractions has been controlled by either the pressure or the temperature in the feed-water heater.

A third class of machines for central-station work consists of a number produced for central heating plants in large cities. These units are of various types, some being straight non-condensing with high engine efficiency, others being equipped with two or more points where steam is extracted.

In the industrial field many machines have been shipped for straight condensing operations, although it is beginning to be appreciated by industrialists that where they need power only and have no corresponding heat demand, they can often purchase their electricity more cheaply from central stations than they can produce it themselves. The few cases where machines of this type are now required, are in plants where some peculiar condition of speed or continuity of service demands that the generating equipment be under local control. The usual type of machine for the industrial plant is one that produces, not only electricity, but also heat for process or building heating. Many machines of this type have been shipped with arrangements for extracting steam at one or more pressures. Some have been equipped with provision for process steam extraction at two points besides the exhaust and for feed-water heating at two other points.

In cases where the demand for process steam is greater than the steam necessary to produce the required electric load, straight non-condensing machines have been installed. In other cases machines have been installed where demands for variable frequency are to be met, as in electric ship propulsion, sugar mills and centrifugal pumping plants.

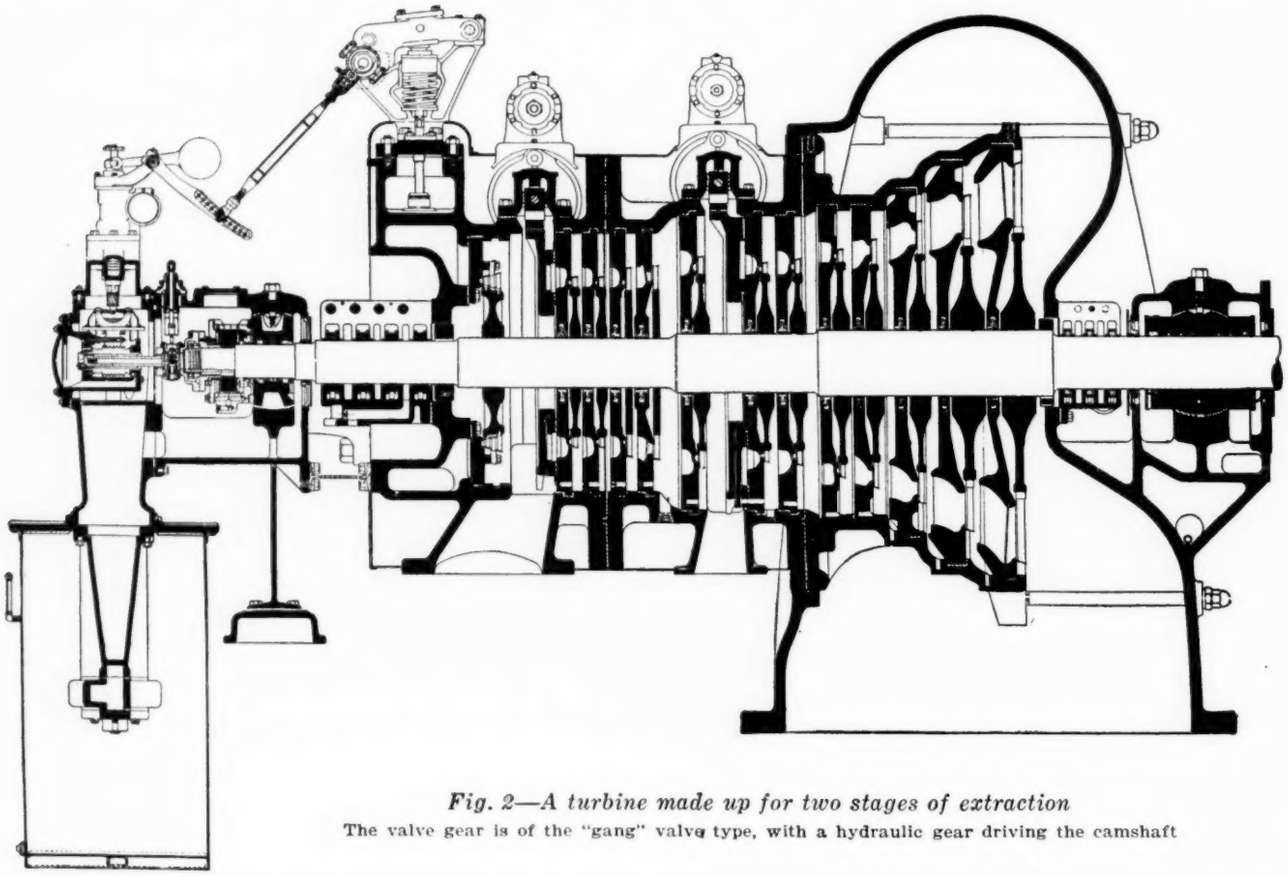


Fig. 2—A turbine made up for two stages of extraction

The valve gear is of the "gang" valve type, with a hydraulic gear driving the camshaft

But, aside from the problem of producing an efficient machine to meet variable steam conditions, it became necessary to provide a great variety of governing arrangements. The usual speed-regulating governor for machines of this type consists of a simple, spring-loaded fly-ball governor, driven from the mainshaft by means of worm gear at approximately one-sixth of the turbine speed. This governor is equipped with hand- and motor-operated speed-changing arrangements by which the speed may be varied between 500 and 750 r.p.m., the normal speed of the governor being 600 r.p.m. A governor of this kind controls the flow of high-pressure steam to the turbine and is employed in all

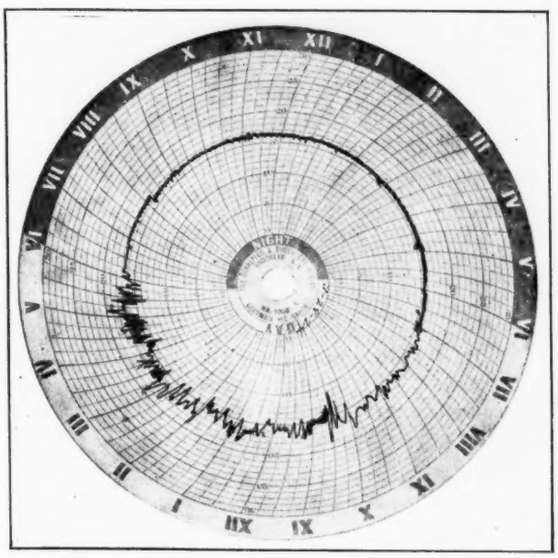


Fig. 3—Exhaust pressure with automatic (above) and hand control (below), with continuous steam demand

turbines of this type, whether they are built for straight condensing operation or for steam extraction purposes, so that the unit is always protected against overspeeding.

There is also provided with each unit an emergency governor which is entirely independent of the speed-control mechanism and operates on an independent valve to limit the speed of the unit to approximately 10 per cent above the normal running speed.

These mechanisms constitute the control of straight condensing units and also of units equipped for reducing valve extraction; that is, for extraction in which the stage pressure of the machine is not maintained constant, but varies with the turbine load, pressure control (if any) being obtained by means of an external reducing valve.

The next simplest form is the case of the straight non-condensing unit in which it is desirable to maintain constant pressure in the exhaust and vary the electrical load to give this. Such turbines have been produced operating with back pressures from 1 to 200 lb. per sq.in. gage. The pressure in the exhaust casing is, in this case, maintained essentially constant by the use of a back-pressure regulator. This regulator consists, in general, of a spring-loaded diaphragm upon one side of which the pressure of the exhaust steam is applied. This diaphragm moves an electrical arrangement which operates the synchronizing motor, so changing the relation of the valve opening to the position of the governor. Machines of this kind, of course, have to drive alternating-current generators which are synchronized on a system that is at least twice as large as the load variations on the machine under consideration, so that the rest of the system will maintain the frequency. In this way the high-pressure valves are opened and closed by the synchronizing motor and practically constant exhaust pressure is maintained.

The curve shown in Fig. 3 is typical of this class of control. The lower portion of the curve shows the effect obtained by operating with hand regulation and the upper portion with automatic back-pressure regulation on the turbine. This curve was taken in a large industrial plant running continuously 24 hours per day with one of the turbines that is being discussed here.

Where extraction of steam is desired from machines operating either condensing or non-condensing, arrangements are made to control the machines so that either essentially constant pressure in the extraction lines or essentially constant load with varying extraction, or both, may be obtained.

In the case where reducing valve extraction is desired, great care has to be exercised in the selection of reducing valves that are expected to work in conjunction with the regulating devices of the turbine, and in some cases it is necessary for the turbine manufacturer to design and build the reducing valves for the particular requirement.

Cases of this kind have been met where it has been found best to design a very efficient turbine for the average process-steam requirement and to take care of the larger steam demands for process work by a specially constructed reducing valve operated by the turbine governor in parallel with the turbine inlet valves.

Other machines have to operate with widely varying steam and electrical demands that are independent of each other. In cases of this kind the turbines are equipped with an internal valve to maintain the pressure in each extraction stage, and so constructed that the residual steam over the requirements of the extraction line is passed on to subsequent stages of the turbine. There may be one or more of these internal valves in the turbine, each holding a different pressure. In some classes of work, such as paper mills, where constant speed is the prime requisite, regardless of large variations in the extraction demand, an arrangement is made so that these internal valves are connected with the high-pressure steam inlet valve, with a design such that, as energy is removed from the low-pressure end of the turbine, an equivalent increase in energy is obtained in the high-pressure end. Many machines of this type are operating with variations in process steam demand from zero to the maximum non-condensing output of the turbine with practically constant speed.

In other cases non-condensing units equipped with the devices for maintaining pressures in the extraction stages, have also been fitted with back-pressure regulators to maintain the exhaust at a constant pressure.

In the case of turbines requiring controlled speed variations, such as sugar mills, water-works pumps and turbine-driven vessels, the governing devices have been worked out so that speed variations from one-sixth to full speed may be obtained, the unit being able at any speeds to carry loads from zero to maximum with the

same relative change in speed. Even in cases of this kind where variable-speed governors are used, the standard constant-speed governor is not omitted, but acts in the case of overspeeding of the turbine as a pre-emergency, maintaining some speed between that of the variable-speed governor and that of the emergency governor.

Emphasis should be placed on the fact that narrow pressure or speed regulation is not dependent merely on the design of the governing mechanism. It is possible to design the power and speed of the high-pressure valve mechanism to respond satisfactorily to the maximum possible speed variations in the turbine as limited by the inertia and the rotational losses of the unit. When it comes to pressure control, the equivalent stabilizing factors are the capacity of the extraction steam lines and the rate at which the demand of steam is changed. These factors must be taken into consideration in the designing of governing equipment for steam turbines.

Determining Size of Chimneys

By J. G. MINGLE

THIS is the third and last article of the series (See Power for Feb. 16 and 23, pages 247 and 288), and shows how to calculate draft requirements and how to design a chimney of minimum cost.

THE required height of a projected chimney that is to be used in connection with a steam boiler plant is based on the total loss of draft throughout the entire installation, and the required diameter, or area, upon the maximum rate at which gases are generated in the combustion chamber. In determining the size of a chimney, the velocity of the chimney gases is used as a basis of computation, while in the investigation of the draft and capacity performance the weight of the gases is used.

The required height of a chimney is equal to the sum of the various losses of draft throughout the entire installation divided by the theoretical draft per foot of chimney.

The loss of draft through the fuel bed (h_F) is usually determined from a set of curves and is based on the kind of coal burned and also the rate of combustion in pounds of coal burned per square foot of grate surface per hour. The loss should be based on the maximum rate of combustion that it is anticipated will ever be encountered.

The loss of draft through the boiler (h_B) should be obtained from the manufacturer of the boiler that is to be installed. This loss is based on the type and size of boiler used and should also be based on the maximum rate of operation that it is anticipated will ever be used.

The loss of draft through the breeching (h_{Br}) is given by the equation

$$h_{Br} = 0.049 \frac{f W_c B_o L}{T_c} \frac{C}{A} V^2 \qquad (1)$$

in which

f = Coefficient of friction;
W_c = Density of the chimney gases at 32 deg. F. and sea-level atmospheric pressure, lb. per cu.ft.;
B_o = Atmospheric pressure, in. of mercury;
L = Length of breeching, ft.;
C = Perimeter of section, ft.;
T_c = Absolute temperature of the flue gases, deg. F.;
A = Area of section, sq.ft.;
V = Velocity of gases in breeching, ft. per sec.

The loss of draft due to turns or bends (h_T) is given by the equation,

$$h_T = 0.049 X_T \frac{W_c B_o}{T_c} V^2 \qquad (2)$$

in which X_T = number of turns or bends.

The loss of draft due to a sudden enlargement of section (h_O) and the loss of draft through the economizer (h_E) are seldom encountered in an average steam plant installation of natural draft and, for the sake of brevity, will be disregarded.

The loss of draft due to velocity (h_v) or the draft required to accelerate the chimney gases, is given by the equation,

$$h_v = 0.049 \frac{W_c B_o}{T_c} V^2 \qquad (3)$$

in which

T_c = Absolute temperature of the chimney gases in degrees F.;
V = Actual, or working, velocity of the chimney gases, ft. per sec.

The loss of draft due to friction in the chimney (h_f) is given by the equation,

$$h_f = 0.049 \frac{f W_c B_o L}{T_c} \frac{C}{A} V^2 \qquad (4)$$

in which

L = Length of friction duct, or the distance between the bottom of the breeching opening and the top of the chimney, ft.;
A = Area of section of chimney, sq.ft.;
C = Perimeter of section of chimney, ft.

The primary equation for the capacity of a chimney may be transformed as follows:

$$A = \frac{W_p T_c}{16.43 B_o W_c V} \qquad (5)$$

For a circular section:

$$D = \sqrt{\frac{W_p T_c}{12.9 B_o W_c V}} \qquad (6)$$

It will be seen that both the required height and the required diameter of a chimney depend upon the velocity of the flowing gases. The various losses of draft can all be referred to a common velocity such as that of the chimney gases. Therefore it may be stated that both the required height and diameter of a chimney vary with the chimney-gas velocity, the former directly as the square and the latter inversely as the square root of the velocity. In designing a new chimney, a different combination of height and diameter will be obtained for each different chimney-gas velocity assumed. For a comparatively low velocity a relatively

low height and large diameter or area will be obtained, and for a comparatively high velocity a relatively great height and small diameter or area will be obtained.

Most Economical Gas Velocity

It is apparent that the cost of a chimney depends upon both its height and its diameter. Since small height involves large diameter, and small diameter, large height, a compromise must be sought. If it be assumed that the cost of a chimney depends upon the product of height by diameter, then the least cost will correspond to the gas velocity for which this product is a minimum. With the aid of the calculus and by making several simplifying assumptions and approximations, the author has developed the following formula for the most economical gas velocity:

$$V = \sqrt{\frac{K_d T_c (h_F + h_B)\sqrt{W_p T_c}}{3K_d(X_T + 1) + 1.4K_d l + 2.1(h_F + h_B)}} \qquad (7)$$

This equation is the starting point in the solution of all problems relating to the determination of the required size of a chimney for any one set of operating conditions.

As an example, let us determine the height and diameter of a chimney to satisfy the following operating conditions:

T_c = 600 deg. F., temperature of chimney gases,
T_o = 60 deg. F., temperature of outside air,
B_o = 29.00 in. of mercury, observed atmospheric pressure,
W_p = 100 lb. of gases per sec., maximum amount generated,
l = 50 ft., length of breeching,
2 turns or bends in path of gases,
h_F = 0.40 in. of water, loss of draft through fuel bed,
h_B = 0.60 in. of water, loss of draft through boiler,
0.084 probable density of the chimney gases at 32 deg. F., and sea-level atmospheric pressure, lb. per cu.ft.
20 ft., distance between bottom of breeching and bottom of chimney.

The theoretical draft per foot of chimney, K_d = 0.00696 in. of water.

The economical velocity, from equation (7), V = 30 ft. per sec.

It will be necessary to determine the size of the breeching before the loss of draft through it can be ascertained. From equation (5), assuming a velocity of 30 ft. per sec. for the flue gases, A = 88.4 sq.ft. Assuming a rectangular section with ratio of sides of 2:1 gives height = 13.30 ft., width = 6.65 ft., and C = 39.90 ft.

From equation (1) h_{Br} = 0.037 in. of water.
From equation (2) h_T = 0.203 in. of water
From equation (3) h_r = 0.102 in. of water

The loss due to friction in the chimney cannot be determined at this stage of the solution, since the size of the chimney is as yet unknown. Therefore, it is necessary to assume a value for h_f. Let us assume h_f = 0.10 in. of water.

Summarizing:	h_F = 0.40	in. of water,
	h_B = 0.60	" " "
	h_{Br} = 0.037	" " "
	h_T = 0.203	" " "
	h_r = 0.102	" " "
Assume	h_f = 0.10	" " "
Total trial loss	= 1.442	in. of water.

The first trial height equals $H = \frac{1.442}{0.00696} = 207$ ft.

In order to check the assumed loss due to friction, it is necessary to know the diameter of the chimney. This may be ascertained from equations (5) and (6): A = 88.4 sq.ft., and D = 10.6 ft.

Then from equation (1), h_f = 0.115 in. of water.

Since the trial value for h_f is greater than the assumed value, another trial must be made. Assume h_f = 0.115 in. of water. Then D_f = 1.457 in. of water, and H = 209 ft. Finally, h_f = 0.115 in. of water.

Therefore, the proper size of chimney as required by the operating conditions noted is 209 ft. in height and 10.60 ft. in diameter.

A common method of determining the required size of a chimney is to select it from a table of chimney sizes for boiler horsepowers. This is dangerous practice, and more often than not the wrong size will be selected. If this practice were amplified by investigating the draft and capacity performance of the size selected, all would be well. There are about a dozen factors that influence the size and that cannot possibly be taken into consideration in a table. Even though average conditions are assumed in constructing the table, yet a variation from the average in only two or three of these conditions will alter the size greatly.

The method presented here of determining the required height and diameter of a chimney is short and accurate and has the advantage of taking into consideration all the factors that affect the size.

Stopping High-Speed Electric Elevators

When stopping high-speed elevators from full speed, the brake should apply rather slowly to permit the dynamic stopping action of the motor to come into full effect. At low speeds such as are obtained when leveling the car to a landing, the brake should apply rather quickly to prevent overhauling of the motor if quick stops are to be made conveniently.

On one make of equipment, to obtain a quick brake application when inching, a resistance of a high value is connected across the brake coil, which permits the brake magnet to discharge rapidly and apply the brake. For the slow applicaiton of the brake shoes a parallel resistance of a low value is provided. The circuit for this resistance is so arranged that it is not connected in until a predetermined high speed is obtained. The manner in which this is done is by the use of a magnet across the armature terminals, which will not close the resistance contact until the voltage across the armature terminals has reached a definite value, which will be a measure of the speed of the motor. At this time the low-resistance circuit will be connected across the brake-magnet coil and a slower application of the brake will be obtained.

In place of the series resistance and contact for short-circuiting the same, a compound-wound brake magnet is sometimes used. This permits the brake to release more quickly as the load on the elevator is increased, since the series winding of the brake magnet is connected in the armature circuit. A contact is also used in connection with the brake in this case to provide for short-circuiting the series winding after the brake has lifted.

Factors Affecting Ammonia Compressor Efficiency*

By J. H. H. VOSS
Consulting Engineer, New York City

THE indicated or compression efficiency of an ammonia compressor is influenced by so many factors that for the practical engineer it is desirable to have a guide showing how to apply systematically well-established rules resulting in improvement of plant operation. It is desirable to know what the ammonia

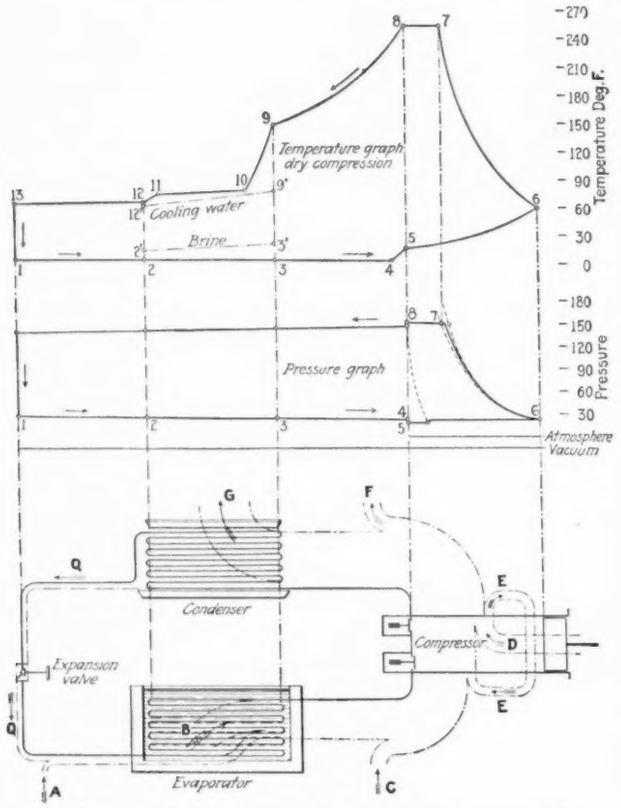


Fig. 1—Doederlein's heat-flow, pressure and temperature graphs

does and its corresponding pressure and temperature conditions. This is well explained by Doctor Doederlein's graphic methods, shown in Fig. 1. How the indicator diagram shows mistakes in design, maintenance or operation is exemplified in fourteen different diagrams of Prof. G. Lehnert, reproduced in Fig. 2.

Referring to the lower diagram in Fig. 1, a unit of liquid ammonia with the heat content *Q* passes the expansion valve. On the way to the evaporator there is a small heat absorption *A* caused by heat entering through the liquid line. In the evaporator the ammonia takes up the largest amount of heat *B* which consists of the desired refrigerating effect and the radiation loss through the walls of the brine tank. From the evaporator coils the ammonia gas is drawn by the compressor through the main suction line into the cylinder, and *C* represents heat radiation picked up in the suction line.

The addition *D* is the amount of heat equivalent to the indicated horsepower required for lifting the heat contained in the ammonia vapor from the low-temperature level of the low-pressure side to the high-temperature level of the high-pressure side. The leakage and the heat exchange in the compressor cause a return flow of heat shown by *E*, which is a heat loss equivalent to a part of the work done in the compressor.

After compression the heat is thrown off again, and the first decrease is shown by the loss *F* in the discharge line. A large amount of heat *G* is thrown off into the condensing water and carried away by it. While throwing off the heat in the condenser, the ammonia is liquefied again and returns to the expansion or regulating valve with the heat content *Q*.

Just above the heat diagram is the pressure graph. This shows clearly the interdependence of all the parts of the system. High resistance in the pipe lines or in the condenser or expansion coils must be overcome in the compressor and by causing excess cylinder pressure, increases the indicated horsepower.

Above the other two diagrams is shown the temperature graph for the dry operating condition. In it the unit of liquid ammonia may be followed from the point 13, where it enters the expansion valve, over points 1, 2, 3 and 4, through the liquid line, the expansion coils and the suction line. At point 5 it enters the compressor, where, between points 5 and 6, a variable suction superheat depending upon operating conditions, is shown.

The compression starts at point 6 and ends at 7. From points 7 to 8 is the expulsion period. Somewhere between these points the highest temperature occurs. Between 8 and 9 the temperature falls rapidly; first the superheat is thrown off, partly in the discharge line, but mainly in the first pipes of the condenser. At point 10 the condensing temperature is reached and liquefaction begins. The temperature remains uniform up to point 11, where a further drop in temperature is obtained by means of a liquid cooler for precooling the liquid to a point as near as possible to the lowest temperature of the available cooling water. Points 12′ and 9′ show the rising temperature of the condenser cooling water and allow a fine comparison with the temperatures of the ammonia inside the coils.

The points 2′ and 3′ show the temperature decrease of the brine which is circulated through the evaporator.

These graphs show the importance of facilitating the work of the ammonia gas or liquid by all the means known to modern refrigerating engineering. Requirements in general are as follows:

In the main suction and discharge pipes a gas speed of not over 5,000 ft. per min. and in the liquid pipes a speed of liquid not exceeding 200 ft. per min.

*From a paper presented at the annual convention of the National Association of Practical Refrigerating Engineers, Detroit, Mich., Dec. 8-12, 1925.

There should be no sharp elbows or tees in pipe lines; use bent pipes and oversize stop valves.

Use good-sized insulation on low-pressure side apparatus and storage rooms and all low-pressure pipe lines.

Use large heat-transmitting surfaces on both the low- and the high-pressure sides. Heat transmits most efficiently in apparatus with large surfaces and small inside volume.

Run the ammonia compressor on the "dry" cycle, but do not superheat the suction gas before it enters the compressor. Carry the suction side white frosted and the discharge hot is a good rule to follow.

Do not pump liquid with the compressor; install a liquid separator near the compressor on the low-pressure side and pump the accumulated liquid back into the liquid receiver or into the expansion coils.

Watch the relative position of the apparatus; place the low-pressure side below the liquid receiver and by all means avoid goosenecks in the high- or low-pressure liquid or main piping.

Do not place the condenser and liquid receiver in the hot engine room.

Precool the liquid just before the expansion valve, using only the coolest water available.

See that the system is cleaned out regularly and keep a written record of the oil input and withdrawal, so it will be known where the oil goes. To protect the compressor use a suction trap.

See that the compressor piston rings and especially the valves are tight and that the valve springs are neither too strong nor too light.

Use good ammonia, test it and keep it free from foreign gases.

Prof. G. Lehnert's indicator diagrams in Fig. 2 show up some of the defects common to compressor operation.

Diagram 1 shows the normal indicator diagram with adiabatic curve ending at *A* and isothermic curve at *H*.

Diagram 2 shows an imperfectly written card owing to the incomplete opening of the indicator cock throttling the gas in the connection.

Diagram 3 shows too large clearance space or that there is liquid present in the cylinder.

Diagram 4 shows that the lift of the discharge valve is too great and the valve does not function properly.

Diagram 5 shows that when the suction valve opens, it sticks.

Diagram 6 shows that the piston is not tight. The compression curve is below the isothermic.

Diagram 7 shows great resistance in the main pipe lines and in the expansion coils and the condensers.

Diagram 8 shows a great resistance against the opening of the valves.

Diagram 9 shows a great leakage of the valves; the corners at the end of compression and at the beginning of the suction are rounded off.

Diagram 10 shows the discharge to be abnormally hot, which is shown in the abnormally high position of the compression curve and the abnormally small re-expansion curve.

Diagram 11 at *C* shows that the piston of the indicator sticks.

Diagram 12 shows that the discharge valve sticks.

Diagram 13 shows that the drum of the indicator is too short. The diagram is reduced in size and the suction line is partly vertical.

Diagram 14 shows that the dimensions of the valve springs are incorrect.

The defects that have been mentioned in the foregoing cause either a decrease in the desired refrigerating effect or an increase in the indicated horsepower. Either would tend to decrease the compressor efficiency and the over-all efficiency of the plant. Therefore, it is of the first importance to get every part of the machine, and especially the compressor, in first-class operating condition, particular attention being given to the compressor valves.

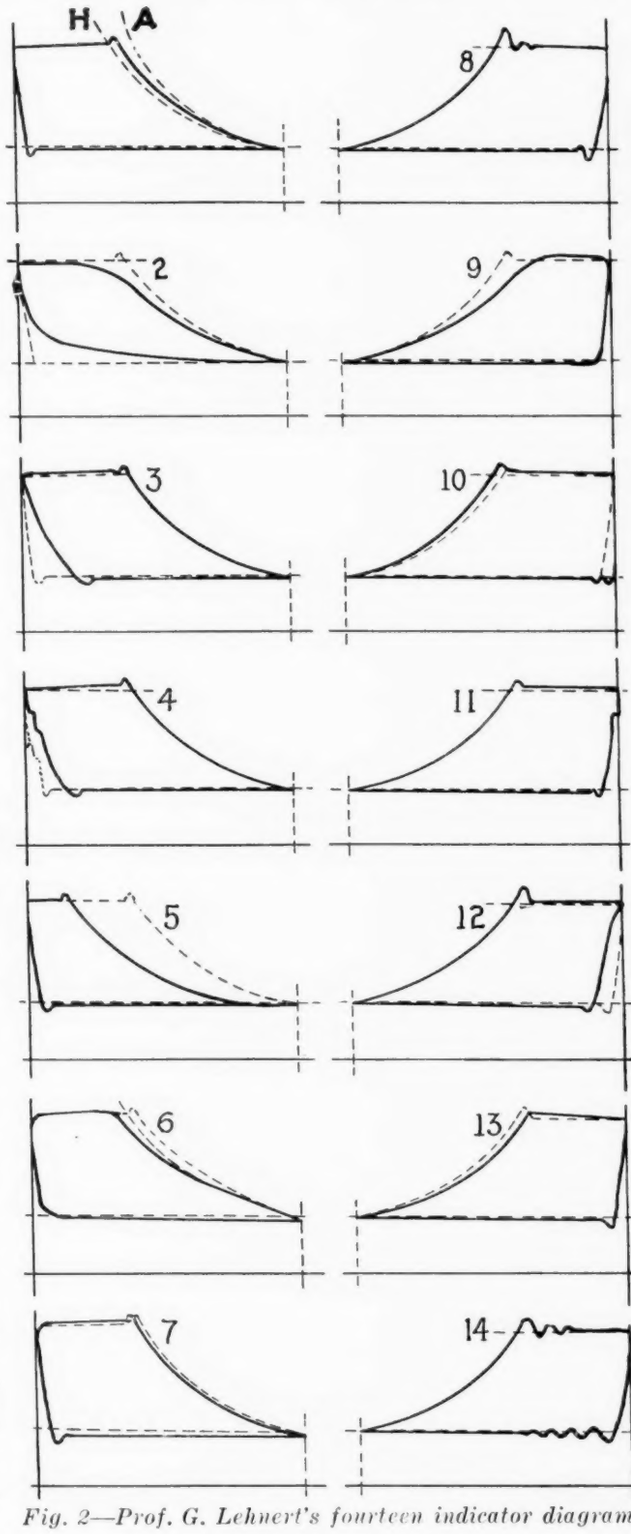


Fig. 2—Prof. G. Lehnert's fourteen indicator diagrams

Automatic Substation Installed in Office Building

An interesting method of supplying and controlling power is followed in the new five-story office building of the McKinney Steel Co. at Cleveland. Mill power is used, but since this is 25-cycle and subject to voltage fluctuations, a substation is used which is entirely automatic in operation and by means of which the power is changed to direct current.

The use of an automatic substation eliminates operation expense, provides complete protection and allows the equipment to be started or stopped by the janitor of the building and, in case of emergency, by any of the tenants. The substation contains two 100-kw. General Electric motor-generators, consisting of 25-cycle squirrel-cage induction motors driving three-wire direct-current generators. With these generators 230 volts for power and 115 volts for lighting is obtained.

In operation one of the sets is started by means of a remote-control push button. If the power supply voltage at the time is sufficient, the motor of this set will be connected automatically to the half-voltage starting tap and, on reaching nearly full speed, will be automatically connected to full voltage. If the load on this generator reaches a value beyond that which it can carry without undue heating, the second set starts up and goes on the line automatically. If the combined load is below a certain value and the two machines are underloaded, the second machine will automatically shut down. The first unit, however, must be shut down manually by means of the remote-control switch.

If, for any reason, the first set fails to start, the second will take its place automatically. If both machines have been running and the trailing machine shuts down, it cannot come back on the direct-current line unless the leading machine is carrying load, thus providing reverse-power protection.

Incoming lines are protected by overload relays, operating on a line oil circuit breaker which must be manually reclosed after interruption. Generators are shunt wound and are provided with counter-electromotive-force regulators of the automatic type. These not only hold constant lighting voltage under normal conditions, but also lower the load by reducing the voltage if the machines become overloaded.

The system is also protected against damage from single-phase starting, alternating-current undervoltage, wrong polarity, overheated motor windings, hot bearings, alternating-current overland, failure to start, incomplete start, reverse power, direct-current undervoltage, continued unbalance of system, grounding of motor or generator windings and overload on incoming lines.

Regulation of Load on Industrial Power System

A new and interesting installation of load regulating and transfer equipment was recently made by Rockwood & Co., cocoa and chocolate manufacturers in Brooklyn, N. Y. This company purchases most of its power in the form of alternating current on a maximum-demand basis, and the object of installing the new equipment is to maintain the load on the power lines as near the agreed maximum demand as possible.

A large proportion of the plant load is alternating current, but there is also a large number of direct-current motors and other apparatus. Power for the alternating-current load is supplied direct from the incoming power lines through transformers, but power for the direct-current load is supplied by two generators, operated in parallel, on the premises. One, a 200-kw. machine, is driven by a Corliss engine which also drives a mechanical load, and the other, a 300-kw. machine, is driven by an alternating-current motor.

As the alternating-current load varies rapidly, it was difficult to hold the maximum demand within the necessary limits. With the present regulating equipment the proper load demand on the incoming alternating-current lines is maintained by automatically transferring the excess load to the 200-kw. engine-driven generator or vice versa.

When the two direct-current machines are first started and the load begins to come on, the current divides between them in proportion to their respective capacities. As soon as the load on the 200-kw., engine-driven generator reaches approximately 25 kw., any load above that point is diverted to the 300-kw. motor generator until the maximum alternating-current demand has been reached. When this generator is loaded to capacity, any additional load is diverted back to the 200-kw. machine until both are operating at maximum load, when a gong rings, calling attention to the load condition. If the maximum alternating-current demand is reached before the 300-kw. generator is fully loaded, the excess direct-current load will be automatically transferred to the 200-kw. generator. The engine which drives the 200-kw. generator is running at all times, driving its mechanical load, its generator either running light or carrying that portion of the direct-current load necessary to maintain the load balance.

The load-regulating equipment was designed and built by the General Electric Co. in co-operation with the engineers of the Brooklyn Edison Co. and Rockwood & Co. It consists of a contact-making wattmeter, which is directly responsible for the master control of the system, and various relays, contactors, etc., for shifting the load, protecting the equipment, ringing the gong, etc. Push buttons and switches provide for hand control of the system when necessary.

A great deal of difficulty has been encountered by power-station operators due to faulty readings obtained from both indicating and recording types of instruments, and they have been put to considerable expense in testing in order to determine whether the location of an instrument is faulty or whether the apparatus is not meeting the performance guarantee. One difficulty is the accurate measurement of the temperature in the exhaust neck between turbines and condensers. It is found that especially at light loads this passage is subject to eddy currents, and it is difficult properly to locate connections for the vacuum gages and for thermometer bulbs which will give a true average reading. Readings reported by different companies taken at various points in the turbine exhaust show a variation as high as three or four degrees.—*Prime Movers Committee, N.E.L.A.*

A vertical engine built by John George Bodmer, installed at the works of Bridson & Sons, in Bolton, England, in 1846, was still working in the fall of last year.

Franklin Van Winkle

IT IS with deep regret that we announce the death on February eighteenth of Franklin Van Winkle, for the last fourteen years a member of the editorial staff of *Power* and a contributor to its pages for many years previous. Through his handling of the "Questions and Answers Department," Mr. Van Winkle came in intimate touch with a large circle of readers who we believe will sense a personal loss in his death. A more extended obituary will be found on page 344.

The Long Hour Shift

WHILE in parts of the country industrial works are able to function successfully upon eight- or nine-hour shifts, in the South not only is the common unskilled labor expected to work eleven or twelve hours a day, but the plant engineers are required to have shifts of twelve and thirteen hours. It is debatable whether with such long hours unskilled labor is able to give a full day's work, but obviously a skilled man such as is necessary in a modern factory power plant, cannot give his best under such long hour service. Inasmuch as even Sunday is for the engineers a day of labor, it is not surprising that many of the better grade seek to locate elsewhere.

If, as is claimed by many of the industrial leaders, the Southern engineer, being of pure Anglo-Saxon stock, is not prone to unite in demanding more advantageous pay or working hours, the natural inquiry is, Why impose on him?

The Value of a Water Power

IN ESTIMATING the value of a water power, an important consideration is what is referred to as its "primary" capacity.

The flow of most streams is variable. Some are very flashy, from freshets in the spring to a comparatively meager dry-weather volume.

Any fair and intelligent estimate of the value of the stream as a source of power must take account of this variability.

For any purpose that demands a constant supply of power a stream can be depended upon for only the capacity afforded by its minimum flow, and the cost of its development may be excessive per available horsepower or kilowatt for this minimum, or primary, yield.

But, as was pointed out by L. F. Haza at the recent Midwest Power Conference, the principal items in the cost of the original development are those of the dam and the land submerged by its construction, and necessary for the works, the possible moving of roads, buildings, etc. Once this has been paid, the cost per kilowatt of further units is comparatively small.

And so, when uses exist for this somewhat intermittent power—and much of it is available for a large proportion of the time—it can be developed at a small cost per unit.

For connection with systems where there is a diversity of demand and where the industries and services connected are not dependent upon this single source, or even for an industry or collection of industries whose processes are varied and admit of accumulative operation in times of plenteous flow, the value of a project is bound to be much greater than that based upon the lowest flow with which the river can be charged over years of gaging.

There is, therefore, a chance for large differences in the value of a project as estimated by those whose interests are served by minimizing its importance and those who seek to profit by booming it.

"Bleeder" Engines

WHILE the reciprocating engine has been almost completely supplanted by the turbine for the generation of large blocks of power in central stations, early predictions of the passing of the reciprocating engine in the industrial plant have not been fulfilled, although, of course, the turbine plays an important part in that field. At the present time competition is keen in the small and medium-sized units. It is strange, when one stops to think of it, that two such fundamentally different machines should run such an even race. The answer is that necessity is the mother of invention. Without turbine competition the builders of reciprocating engines might have stayed content with the Corliss, which, as a neat and smooth-running mechanism, has never been surpassed. Strictly speaking, necessity may not have invented the unaflow, but it has certainly had much to do with its commercial promotion on a large scale.

Now two new factors are becoming almost daily more prominent. They are higher steam pressures and by-product power. The turbine and engine both fit in nicely as back-pressure machines exhausting to process. Where condensing operation is convenient, the power requirements relatively high and the power and steam requirements somewhat "out of phase," the bleeder turbine has made great progress. Its flexibility is ideal, permitting generation of all power above that producible from the process steam by steam expanded to condenser pressure.

The compound engine—so much less common now than formerly—found the chief reason for its existence in the necessity for increasing efficiency by reducing initial condensation. The unaflow, accomplishing the same result in a single cylinder, made compounding apparently unnecessary. But the tendency toward much higher steam pressures may again increase the field for

compound engines. For one thing simple engines already installed may in some cases be cheaply adapted for higher pressures by the addition of a small high-pressure cylinder. Again, compounding of new engines is perhaps the simplest method of arranging for bleeder operation, steam being bled from the receiver between the two cylinders.

There is nothing new about this method of operation. It was tried out years ago and is today used in a few installations. But the thought arises that the day may be approaching when there will be an intensive commercial development along this line and when it will become common practice in industries with relatively high power demand to employ compound engines operating with pressures of four hundred pounds or higher and bleeding to process between expansions. Catalogs recently received from France and Germany indicate that European manufacturers anticipate a substantial demand for plants of this type.

Overmotoring Not Always the Power User's Fault

AFTER all the study that has been given to electric-motor applications, there still seems to be a lack of exact information on selecting the right kind of a machine for a given job. When a group of motors was operating at half their rated load or even less, somebody made a serious mistake in determining the size of the equipment, an error that never would have been made if exact data had been available on what the requirements were. Overmotoring has been indulged in for a number of reasons, among which are: Wanting to be sure that the motor was large enough, lack of information on the requirements, restrictions as to starting current, motor not suited to the service, and starting-torque requirement.

Overmotoring has little to recommend the practice on economic grounds. First of all it makes the cost of installation unnecessarily high. Motors operating partly loaded have a lower efficiency than the proper size machine to drive the load, operating at near full load, consequently with too large a motor for the application the cost of power will be higher than it should be. On alternating-current circuits overmotoring causes low power factor and this is reflected in the system back to the generators, not only in increased cost of equipment and operation to supply a given load, but frequently the quality of the service is impaired. With direct current a partly loaded motor may give a little less trouble at the commutator than when fully loaded, but as the modern motor is designed and built, this factor loses much of its importance. On alternating-current motors no such redeeming feature can be charged to the credit of overmotoring and low power factor makes it very undesirable.

Some of the power companies have rigid restrictions as to the starting current allowed to be taken by an alternating-current motor from their lines. This restriction is generally based on so many amperes per horsepower. Not infrequently, the customer, not wishing to get into any difficulty due to excessive starting current, installs a motor large enough to start the load with a safe margin of starting current per horsepower. In doing this, the total starting current has not been reduced, and in addition a low-power factor load has been put on the system due to the motor's being oversize.

Investigations have shown that it is not the starting current taken by the motor that causes voltage disturbances on the system so much as how suddenly this load is applied and its power factor. This fact has made the resistance type of starter, of proper design, in many cases preferable to the auto-transformer for starting squirrel-cage motors. To start a given load, the current taken from the line through the resistance type of starter will be higher than with the auto-transformer. Resistance types of starters can be designed with little or no increase in cost, to build the starting current up slowly on the motor, and this allows the system to accommodate itself to the load conditions.

When starting by this method, the power factor of the starting current will be higher than with an auto-transformer, consequently the effects to cause a voltage drop in the lines and generators will be less. In this respect the resistance type of starter offers possibilities for reducing disturbance due to starting. The application of motors to obtain the most suitable installation is by no means an exact science and probably never will be, but a better general understanding of the factors influencing the problem, and co-operation among those who are interested in making such installations will do much to improve some of the bad examples now existing in many plants.

Standardizing and Sectionalizing the Steam Turbine

AN ARTICLE in this issue describes what has been done by one of our large turbine manufacturers in the direction of developing a line of turbines readily adaptable to a wide variety of operating conditions. This has been done by the design of a series of standard sections that can readily be bolted together in various combinations so as to build up turbines suitable for a wide range of initial steam conditions, exhaust pressure and extraction requirements. As might be expected, much ingenuity has been expended in the design of various types of governors for this line of steam turbines.

This development should open the way for high-grade engineering design in many plants where the expense incident to the design and manufacture of a special turbine would be out of the question.

It is natural to wonder in this connection whether something of the same sort could not be done with larger machines. Of course it is true that the service requirements imposed on large turbines are more nearly uniform than those prevailing in the case of small machines. On the other hand, the expense of preparing patterns and machine-shop equipment for the building of a large turbine is so very great that it seems highly desirable to distribute that expense over as many units as possible. There have recently been several instances of the clever adaptation of turbines designed for one set of conditions to conditions other than those for which they were originally designed. These successes seem to indicate further possibilities in the direction of standardization.

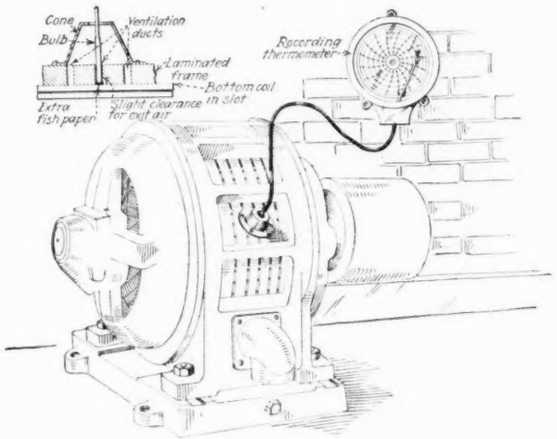
It must not be overlooked that there is danger in this line of advance. Standardization might proceed too far for the good of industry. Designers must remain free to develop progressive improvements, but meanwhile production may be facilitated by a rational application of the principles of standardization.

Practical Ideas From Practical Men

Recording Thermometer Used to Indicate Safe Loading Point of Motor

It occurred to me that the readers of *Power* might be interested in what we have found to be a paying application of recording thermometers.

In our plant there are two 50-hp. motors, which drive important machines, located where the room temperature is 40 deg. C. (104 deg. F.) in the summer and



Bulb of thermometer is placed at hottest point

21 deg. C. (70 deg. F.) in the winter. These are rated at 50 deg. rise above room temperature at full load and frequently are called upon to carry all the overload safely possible. In the winter we have little trouble, but in the summer it is evident that the over-all temperature is at the breaking-down point of the insulation. The usual method of limiting the current to full load rating or a conservative overload, by means of fuses or relays, could not be used, since the safe point would vary with the outside temperature.

Since the temperature of the hottest part of the winding was the governing factor, we located the especially shaped bulb of a recording thermometer there and told the operators to carry all the load they needed at any time, so long as the temperature did not exceed 85 deg. C. (185 deg. F.). We located the crucial point with glass laboratory thermometers and it was not between the ends of the coils, as the manufacturers suggested. The hottest point was in one of the exit ventilation ducts in the center, where the thermometer bulb could be in contact with a bar in the bottom of a slot.

The instrument manufacturers made a special bulb which was a nice fit to the ventilation duct. As there must be a limited relation between the volume of the bulb and that of the tube, we limited the length of the tube to 3 ft., so as to reduce the size of the bulb. At that, the smallest bulb stuck out of the duct about 1 in. A cone was fastened around the upper part of the bulb, covering two adjacent ventilation ducts. Thus, the protruding portion of the bulb was bathed with hot air, coming from the adjacent ducts, before passing out the top of the cone.

Unfortunately, one of the motors was burned out before the thermometer was installed and the total cost of the repair must have been $350. The accident has not been repeated in three years, and I know the motors have carried 40 per cent overload at times. It is hard to value the increase in production, due to the extra power available.

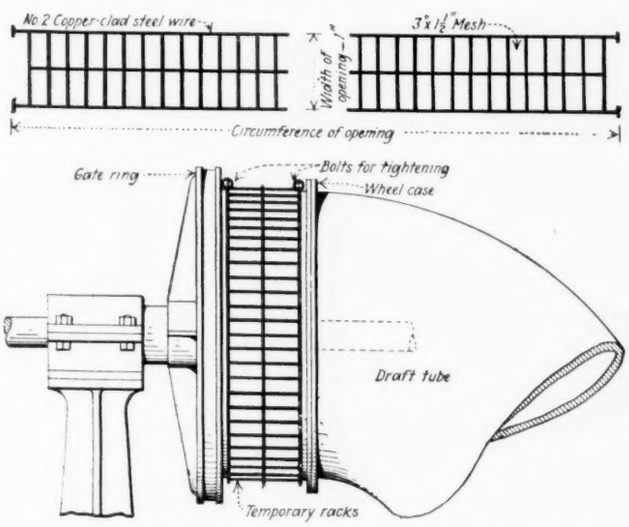
L. W. CULTER.

Bound Brook, N. J.

How the Hydraulic Turbines Were Kept in Operation While the Trash Racks Were Under Repair

As there is nothing new under the sun, the following has doubtless been tried many times. However, it is new to us.

Owing to an accumulation of anchor ice a portion of our racks collapsed. The break was about 25 ft.



Wire screen placed around water inlet to wheel served as trash rack

below the surface of the headwater and made it possible for all kinds of débris to enter the wheel case with its attendant results.

In order that the machine could be kept in operation while we waited for material and divers to repair the break, we decided to place temporary screens around the opening to the wheels.

The wheels are Leffel type 250 hp., and the water in passing to the wicket gates goes through an opening on each wheel, about 7 in. in width and 10 ft. in cir-

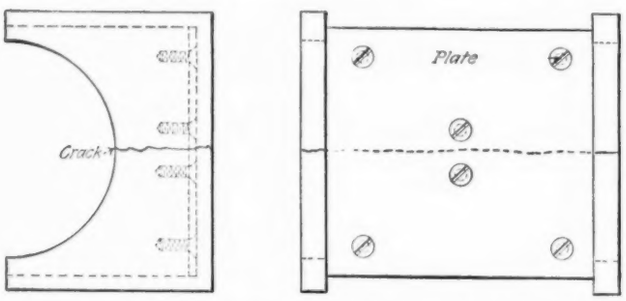
cumference. On these openings we constructed our temporary racks, consisting of wire mesh as shown in the illustration. The material used was No. 2 copper-clad steel wire.

This arrangement made it possible to operate the wheels with safety and as a temporary makeshift saved us considerable trouble and expense.

Bradford, Vt. S. W. KEITH, Asst. Supt., Bradford Electric Light Co.

A Temporary Crankpin Bearing Repair

Some time ago an engineer asked me how he could repair the crankpin brass of his engine, which had cracked somewhat as shown in the illustration. I



How the crankpin bearing was repaired temporarily

suggested a plan I had seen successfully used some years ago.

First the babbitt metal was removed, then six holes were drilled and threaded, three on each side of the crack. An iron plate was then fitted to the brass and six holes drilled slightly off center with the other holes, so that when the screws were tightened up, they would tend to draw the sides of the cracked bearing together. New babbitt metal was then poured and the bearing turned out in the lathe. The tops of the screws were riveted over to prevent their loosening up.

Toronto, Ont., Canada. J. E. NOBLE.

How the End Thrust Was Removed from a Double-Suction Centrifugal Pump

Among the pumps of a plant that I had charge of, was a 6-in. single-stage double-suction, centrifugal pump that had never done any service since it was purchased, owing to excessive end thrust of the impeller spindle. I learned that my predecessor had tried several types of thrust bearings, none of which proved successful.

I had the pump opened up, and examined the sealing rings for leakage and the suction passages for an obstruction, but could not find anything wrong. The pump was supplied from an overhead tank, there being a vertical drop of about 8 ft. and a horizontal run of about 5 ft.

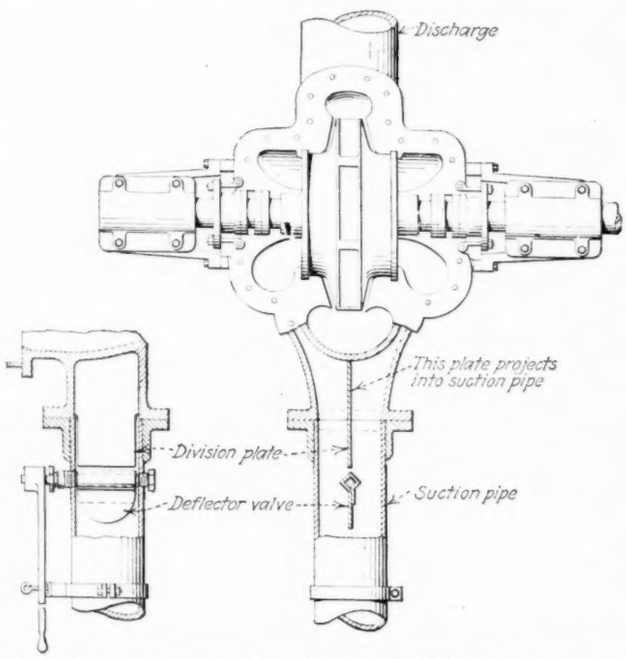
In the past I had always been able to take care of end thrust by the use of thrust bearings or by providing a bypass from one side of the pump casing to the other, thereby equalizing the pressure on both sides of the impeller. With open type impellers, drilling holes through the impeller would sometimes cure end thrust, but this time I decided to try out a method of my own. With single-suction pumps one theory is that the thrust is toward the suction if the liquid enters the pump below atmospheric pressure and away from the suction if the pressure is above atmosphere, while with double-suction pumps there will be no end thrust whatever the pressure of the entering liquid, unless more liquid enters one side of the impeller than the other.

Acting upon this theory, I decided that if I could devise some means by which the amount of liquid going to each side of the impeller could be controlled, I would be able to control the end thrust.

The plan I adopted was to fit a vertical division plate in the suction entrance to the pump. The plate was made of No. 10 gage sheet steel and was secured by inserting its top and bottom edges into grooves cut in the pump casting.

In the end of the suction pipe that couples to the pump, I fitted a half butterfly valve, making provision for operating it from the outside. The valve, which was made of No. 12 gage sheet steel, was fastened to a $\frac{5}{8}$-in. square steel spindle turned at each end to $\frac{1}{2}$ in. diameter, the bottom end of the spindle fitting into a blind brass bushing $\frac{3}{4}$-in. standard pipe size.

The top of the spindle worked in a brass bushing fitted with a packing gland, the bushing being screwed into the pipe. The top of the spindle was fitted with a handle for operating the valve, and holding it in any desired position by pegging it to a bar which was part



End thrust on pump shaft is controlled by deflector plate

of a clamp fastened to the suction pipe. The spindle was placed vertically in the center of the pipe and in line with the division plate. The pump was started with the deflector valve in midposition, and when pumping, I found that as I moved the deflector from side to side, the impeller spindle would also move, thrusting lightly or excessively according to the position of the deflector.

The pump ran without end thrust with the deflector in midposition and gave no further trouble in that respect. E. J. JORDAN.

Long Beach, Calif.

Comments from Readers

Modern Materialism

In reference to the foreword in the Jan. 19 issue on "Modern Materialism" and the criticism of the "Foxboro Reporter," it seems to be true beyond reasonable doubt that the professed followers of Romance and Art are more numerous now than at any other time in history. Observation indicates that they are as innocent of concern with the electric light which assists their sight, the power which whisks them hither and thither, as they are of the sunlight and the wind. They simply accept those things as they are.

To an outsider who, largely through curiosity, has observed them for years, it seems that their poor showing in comparison with the past is due to their own culture. That culture seems to rest, as taught, upon the idea of inspirational magic. Painstaking study, tedious and untiring efforts toward perfection are for the beginners, the tyros, and have little place among the "leaders."

It is taught that only by inspirational magic can the past be equaled, and the idea that it might be excelled is not accepted at all. Whenever, as is sometimes the case, one rebels and does produce things of new beauty, a curious but stultifying snobbery immediately operates to prevent recognition. The result is that in many cases the artist is kept in dire poverty in his lifetime, then, years after his death, comes the recognition which might have stimulated him to more splendid performances. J. R. BELKNAP.

West Toledo, Ohio.

Why the Oil Engine Ran Away

Referring to recent articles appearing in *Power*, commenting on different causes of oil engines running away, I will mention two cases to show how little fuel it requires to make them race when carrying no load.

About 1910, when oil engines were not so common as they are today, a 25-hp. horizontal two-stroke-cycle engine was driving the machines in a small machine shop in the Illinois oil fields. This engine compressed its charge in a cylinder in front of the working cylinder.

One day the clutch was thrown out and the engine allowed to idle during the noon hour. All at once it started to race, and before any one could get to it, it sheared the one-inch foundation bolts.

The witnesses to the occurrence said the oil cup on the cylinder had jarred open, causing an oversupply of lubricating oil to enter the cylinder, which ignited and caused the racing.

About a year later I was in Arkansas installing some of the same type of engines on a rice plantation to pump water wells.

They had put down a well the fall before and tested it out. One day before we were ready to start up, the engineer and I went out to this first well to try it out, and found the pint cylinder cup about half full of thick oil that had been left in over the winter. We filled the balance of the cup with a thin gas-engine oil and started the engine, and allowed it to idle while we went out to the well about forty feet distant.

In about half an hour I noticed the engine speed up, and ran in and threw in the clutch, which stopped it. When starting the engine, I had set the sight feed so it would handle the heavy oil in the cylinder cup freely, but when the heavy oil was exhausted the fresh oil fed so freely that it furnished the engine with fuel enough to race.

In connecting these engines for cooling water I put a check in the line between the circulating pump and the line running from the bottom of the tank to the engine, so that in case of pump failure the water would circulate thermo-siphon. F. E. MYERS.

Charleston, W. Va.

Dressing for Leather Belts

Replying to the letter by Maurice C. Cockshott in the Feb. 2 number of *Power*, probably I did go a little too far in my criticism of neatsfoot oil. I know that neatsfoot oil is used as the base for many of the best-grade dressings on the market, not only for leather belts but for nearly all kinds of leather. Provided the oil is in good physical condition, it is a preservative of leather.

What I said in my letter of Dec. 29 was based largely on the report of a chemist, and it may be that the oils with which he came in contact were not the best.

The chief criticism of neatsfoot oil is, however, not what it does, but what it does not do. For leather on the back of books or in traveling bags, for harness, shoes and such leather which is not under severe stress, neatsfoot is a convenient and good preservative. But when applied to leather belting, its tendency is to make the leather too soft for the stresses to which the belting is subjected. Long-fiber belts of special mineral-tanned leather are probably not weakened so much as the shorter-fiber oak-tanned belts.

Neatsfoot oil does make belts pliable, of course, and it prevents slipping at least to some extent by making the belt more pliable, as a pliable belt will slip less than a dry, hard one.

A belt treatment made expressly for belts gives even better preservative effects and is much better for leather in the form of belting because of its heavier body and because it keeps the belts flexible and mellow, yet dense and firm, instead of porous and flabby.

Mr. Cockshott puts me into a bit of a corner by asking for my formula. I am not recommending any formula in particular, but rather am recommending a manufactured belt preservative which, if of the right kind, will do all that neatsfoot will do and in addition will stop the slipping so that the belts need not be run tight.

To this Mr. Cockshott may ask where such a belt preservative can be found, and I would say that in selecting a manufactured belt preservative the elements

that should guide one would be that it had been on the market for a sufficient number of years for users to have determined its preservative effects over a long period of time and it should be one which could show, not from the statement of the manufacturer, but from recent, definite and undoubted letters, photographs, chemical and mechanical tests, etc., that it would give the results desired.

Most manufacturers of oak-tanned leather belting recommend belt treatment with a compound, often of their own manufacture. I notice in Professor Norman's new book, "Principles of Machine Design," that one prominent manufacturer of a special mineral-tanned belt states that oil is sufficient. Whether or not neatsfoot oil is recommended, he does not say.

Newark, N. J. W. F. SCHAPHORST.

Don't Lean Too Heavily on a Formula

The editorial in the Dec. 29, 1925, issue of *Power*, entitled "Don't Lean Too Heavily on a Formula," prompts me to express an opinion I have held for a long time concerning the value and accuracy of a certain formula that is given in standard textbooks on steam boilers. Here is the disputed formula: Every increase in feed temperature of eleven degrees saves one per cent of the fuel.

Nothing is said regarding the type of boiler being fed, by way of qualifying this statement, yet this is one of the main factors entering into the case. We will consider three types of boiler, and I will show that in two cases from my own experience, I have found the formula far from accurate. One plant had a battery of 84-in. return-tubular boilers operating at 140 lb. pressure and at somewhat above normal rating at all times. Ordinarily, the feed temperature was 210 deg. F. and no trouble was experienced in carrying the load under these conditions. Several times, owing to heater trouble, it became necessary to bypass the heater, and feed water from the hotwell at 110 deg. to the boiler. When this condition arose, it usually lasted an hour or two, long enough for us to note the effects. According to the formula our coal consumption should increase only about 10 per cent, due to a drop of 102 deg. in the feed temperature. But actually we had to burn fully 20 per cent more coal under this condition even though our flow meter showed no change in the steam flow. Often steam had to be shut off from one or more departments in order to hold the pressure up in one or two important processes.

Now with 212-deg. feed water we could easily handle a 10 per cent increase in load with approximately 10 per cent more coal, but with the reduced feed-water temperature it was equivalent to 20 to 25 per cent increase in load as far as the effect on the furnace was concerned. I do not attempt to explain this discrepancy. I am merely setting down facts as they occurred.

In another plant the disastrous effect of low feed-water temperature was fully as bad if not worse. With two vertical fire-tube boilers and 200-deg. feed water the fireman had an easy job. But with a drop of 90 deg. in the water temperature he had to force his fires, and counting the shovelfuls of coal fired in half an hour, the quantity burned appeared to increase by 25 per cent. That there is limited circulation in fire-tube boilers is admitted by anyone who has studied the subject, and a rule of good design is violated since, for fuel economy, the circulation should be such that the counter-current principle be adhered to, that is, the coldest water should meet the coolest gases. In fire-tube boilers nearly the opposite takes place, which may partly account for the excessive fuel consumption with cold feed water.

Now, applying the formula of water-tube boilers of the inclined-tube type, little or no steam is ever generated in the rear bank of tubes in this type of boiler, the heat exchange serving merely to raise the temperature of the water in the last bank. Assuming the feed temperature to be 210 deg. at ordinary ratings and the temperature of the gases entering the last pass to be around 700 deg. F., and the exit temperature 500 deg., the average gas temperature in the rear bank is 600 deg. F. Now with an increase of 55 deg. in feed temperature the theoretical fuel saving is 5 per cent. But with an increase in water temperature in the rear bank the heat transfer will be slower and the gases will leave at a higher temperature.

The fuel loss due to the increased flue-gas temperature should be deducted from the 5 per cent saving that is claimed by the formula. The increased feed temperature will cause the feed water to be evaporated into steam earlier in the circuit. This will reduce the heat transfer slightly, due to steam and not water being in contact with some parts of the tubes, resulting in still higher flue-gas temperature.

Brightwood, Mass. ANDREW F. SHEEHAN.

Write Yourself to the Fore

After reading the Foreword in the Nov. 17, 1925, issue, entitled "Write Yourself to the Fore" I thought congratulations were in order for the editor because of the encouragement he gave to others to write and tell how they were able to overcome some operating trouble by doing the work some other way or were able to do some piece of work more efficiently and more safely by using another kind of tool or method of doing it.

He also said, "The discovery of a man may be as important to the progress of an enterprise as the discovery of a process or the invention of a machine." This we are willing to concede, and the only way that the benefit of a discovery can be known is to "get out your pad and pencil and write yourself to the fore." Send it to some representative journal in the field, and if it is found worthy, they will print it and thousands of engineers will know about it.

I also read the comment on the Foreword in the Dec. 29 issue, by C. M. Durgin, who added the query, "How can it be done?" It can never be done if the other engineers take the gloomy stand taken by Mr. Durgin. I was a subscriber when the present *Power* was known by the name of *Steam*, about thirty years ago, and during this long period of time it has carried to me suggestions from engineers who did not believe in keeping things under their "hats," because that does not help others.

Whenever at our plant an improved method of doing a thing is discovered and our company does not want to keep it secret, I have frequently taken the liberty of writing up the subject and sending it to *Power*. I have received so much help from the suggestions of others that I feel it my duty to reciprocate.

A paragraph of the Foreword, previously referred to, read as follows: "One of the large industrial establishments has an official or department the function of

which is to browse through the current literature of its subject in search for talent," but if the attitude taken in the comment in the Dec. 29 issue was taken, this official would be out of a job, as there would be no new suggestions coming in. It also said that some organizations have a rule that any employee writing for the press must have his manuscript approved by some official before publication.

At the time the editor wrote the Foreword he had in mind one that was capable of writing an article and of knowing of what to write. For many years I have been a contributor to the engineering journals, and when I have shown my employer articles that I have written, he has always made a pleasing remark about them and at no time has he rebuked me for doing so.

My advice is to write articles that are interesting and useful to the engineers and the *big men* will not censure you. THOMAS PASCOE.

Norway, Mich.

Engineering and the Man

I think Mr. Ogur, in his letter "Engineering and the Man" in the Jan. 5 issue comes pretty near the truth in ascribing one of the chief causes of poor engineering salaries to mistraining, though perhaps he would not agree with my version of it. His remarks on the impractical attitude of the faculty are true, and while I regret that I have not had enough contact with the schools or graduates of the so-called co-operative courses, in which the students spend half their time in class work and half working, presumably under regular shop conditions, in various industries, to judge of their results, my own experience of working during vacations made me a firm believer in the desirability of requiring this as part of the course of every engineering student —that he go out and get a job, not as an apprentice but for whatever work and wages he can obtain on his own merits, keep his mouth shut about who he is and see how things actually are done, so that when he does graduate and start to work for a living he will know how to get along with men and not have to spend a year or two creating and getting over unnecessary friction with his fellow-workmen. Such experience also gives a man a better sense of proportion in valuing money, time and materials, provides a tangible framework into which he can fit his facts and theories as taught in the classroom and gives a most convincing demonstration that he is studying not to pass the next examination, but to acquire a tool of use in earning a living

Two features of engineering education rather work against commercial success—first, the emphasis on being absolutely sure the solution proposed is correct and safe and not taking chances; second, the training in looking on all sides of a problem before making a decision.

The first is of course a desirable thing for a designer, in fact necessary, for while some of the other professions may be able to talk their way out of their mistakes and escape in the confusion of arguments, there is little chance to cover a failed structure with hot air. Habits of mind of this sort are bound to carry over into one's general conduct of life and undoubtedly deter men with such training from taking the chances whether as salaried executives or owners involved in business ventures by which the larger profits are made.

The second, inclining a man to see the good points of his opponent's position and the poor ones of his own, as well as the contrary, and also the realization that it is rather presumptuous to assume that one has given correct values to all the elements entering into a question, are likely to make the engineer less assertive of his position and may be crowded out by more ignorant but more positive and reckless competitors.

It is possible too that in this still—in spite of all our paid reformers—somewhat imperfect world the engineering profession as a whole has taken the gospel of service so steadily preached to it in school and out, too seriously, and has considered his employer's interests before their own to the extent that they have reached their present position—whatever that is. I hardly think it is as bad on the average as Mr. Ogur and some of the other writers have suggested, or that it compares so unfavorably in rewards with the legal and medical professions, but I do believe that until some of the Utopias show signs of coming true, as a measure of self defense engineers may be compelled to adopt some features of the physician's code of ethics as to sticking together and of the trades unions tactics of adding emphasis to their demands.

One side of Mr. Ogur's criticism of engineering education does not seem fair. As he says, the students coming to the schools represent an average of those preparing for all professions. I know that most schools observe the first year men carefully and try to weed out those conspicuously unfitted for training and it is asking a great deal of them to do more. Much of the "wet blanket" training to which Mr. Ogur ascribes the loss of "pep," enthusiasm, ambition, self confidence, determination and persistance, is an effort on the part of the college authorities to counteract the bluff and myths regarding engineers' incomes 10 per cent.

Considering the immaturity of students and the importance of personal factors in any man's success, the college can hardly be expected to produce 100 per cent results in developing them into earners of large salaries, but I know it is the impression of most fellow engineers with whom I have discussed the subject that while engineering probably does not provide as many large incomes in its own line as law or medicine, it does provide a larger number of medium-sized ones, and this would seem to be borne out by the recent report of the Society for the Promotion of Engineering Education. This situation may be changed in the future by the present tendency to restrict the number of lawyers and physicians by the leading legal and medical schools, requiring a college bachelor's degree for entrance and, as in the past, a state certificate of practice. Such a system might produce temporary results, but most artificial restrictions of output have resulted eventually in the development of substitutes and a loss on the investment.

Apparently the most promising course at present is for the engineer to develop such sales and business ability as he has, if for no other purpose than to sell his ideas to his employer and get a satisfactory price for them; to study his fellow men, understand their motives and desires and how to influence them, for it is through men that results are achieved and results are what are paid for. This means work beyond the regular hours, but since salesmanship, business ability and political skill command the largest rewards today, however much one may regret it, it is probably easier to develop these qualities to the extent one can and get the corresponding reward than to convert the great indifferent majority of people to another opinion.

New Haven, Conn. H. D. FISHER.

Franklin Van Winkle

WHEN I came to *Power* in 1888, I found the editorial chair that I was to occupy temporarily filled by Franklin Van Winkle.

When I spent the summer of 1900 at the Paris Exposition, Mr. Van Winkle was the one who conducted the paper in my absence.

In 1912 he joined the editorial staff of *Power* permanently, in charge of the "Questions and Answers Department," and in years that have since passed has made many friends for the paper and for himself by his sympathetic, conscientious interest in, and painstaking replies to, the thousands of inquiries that come from puzzled readers.

By temperament, training and experience he was peculiarly fitted for this service. Nothing pleased him better than to be applied to for information, and if he did not know everything that was asked of him he knew where to find it out. Familiar from boyhood with tools and mechanical processes, son of an inventor and engineer, graduate of Stevens Institute of Technology, Professor of Engineering at the Texas Agricultural and Mechanical College, for twenty-seven years a successful consulting engineer in the planning, construction and testing of power plants, inventor of the Van Winkle dynamometer, extensively used for measuring power before it came to be sold by the kilowatt, he was particularly well equipped as a teacher as well as a practitioner for the position which he occupied upon the staff of *Power*.

He was born in October, 1856, of Old Dutch ancestry in Paterson, N. J., where his family had long been active in civic affairs. The home that he occupied at the time of his death was erected by his grandfather and has been the family homestead ever since. Always interested in public affairs, Mr. Van Winkle served for twelve years upon the Board of Health of Paterson and designed the hospital in which he was destined to die. This hospital, the Paterson General, was considered, at the time of its erection, to be one of the best establishments of the kind in the country and was awarded a gold medal at the Chicago World's Fair as a model institution.

Franklin Van Winkle graduated from Stevens Institute of Technology in the class of 1877, which numbered only ten members; eight are still living. He retained a live interest in the Institute and attended the meetings of the Alumni and the commencement exercises faithfully to the last, deriving particular enjoyment from the annual dinner of the surviving members of his graduating class.

He has been a member of the New Jersey Board of Boiler Rules since its organization and held licenses entitling him to practice as a professional engineer in the States of New York and New Jersey.

On Thanksgiving day he attended the Cornell-Pennsylvania football game and contracted a severe cold which resulted in pneumonia, from which he died at the Paterson General Hospital on Thursday, February 18, in the 70th year of his age. He is survived by his widow, Mrs. Anna Shaw Van Winkle; a son, Dr. John Van Winkle, a brother and two sisters. The son was graduated from the University of Pennsylvania as a doctor of medicine and served in the medical staff of the U. S. Navy under Admiral Sims in Europe during the World War.

Personally, "Van," as he was known among us, was a lovable character and his passing will leave a void in the editorial ranks and in the hearts of his associates that will close but slowly with the passing of the years. And the files that he has left are replete with letters of grateful acknowledgment of favors that he has done their writers. Even today the mail brings three communications addressed to him personally expressing gratitude for past attentions and asking further advice.

His was a simple, earnest useful life. May his reward be in proportion to the service he has so widely and willingly rendered, and to the great good will he bore to all mankind.

F. R. Low.

A new slant on things observed in and out of the power plant

What Happens and Why?

A Gearless "Reducing Gear"

THERE appeared recently in a British publication (*Mechanical World*, Jan. 22, 1926) a description of the "Burn" reducing and reversing gear invented by Lewis Burn. Using the information there contained as a basis, the writer of the present article has made a little study of the kinematics of this ingenious device, which he believes will be of interest to the readers of *Power*. Figs. 1 and 9 were sketched from photographs in the *Mechanical World*. The remaining illustrations are original.

Fig. 1 shows a single reducing unit with driving shaft on the left and driven shaft on the right. A single unit of this type gives a positive speed reduction of exactly two to one without the use of toothed wheels of any type. It will be seen that the driving shaft has a double crank forming a tee head. The cranks are of equal length, and each carries a slipper as shown. These run in two slots crossing at right angles on the face of a disk mounted on the driven shaft. The large holes shown in this disk play no part in the operation beyond reducing the weight and flywheel effect of the unit.

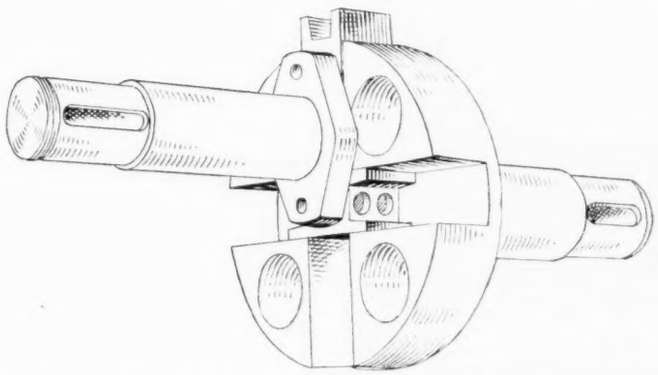
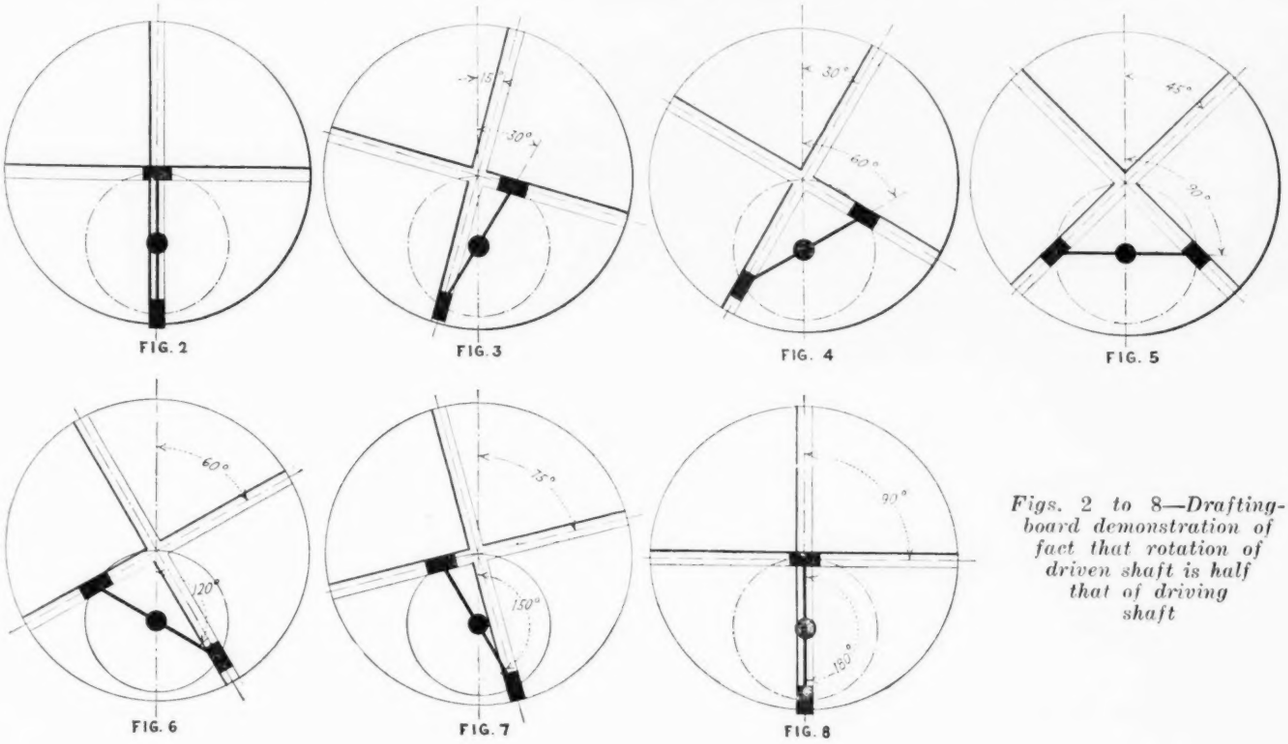


Fig. 1—Driven shaft (right) turns exactly half as fast as driving shaft and in the same direction

The two shafts rotate in fixed bearings, their center lines being parallel and offset a distance exactly equal to the throw of one crank.

Now if the driving shaft is rotated in either direction, the driven shaft will turn in the same direction at just half the speed. This can be seen more clearly by reference to the diagrams shown in Figs. 2 to 8 inclusive. The black solid circle represents the driving shaft. The heavy lines extending both ways from it are the cranks running to pins (not shown) at the center of the solid black oblongs representing the slippers. The driven shaft is in the center of the large circle with the slots.

Taking Fig. 2 as the starting position, imagine the driving shaft turned clockwise 30 deg., as shown in Fig. 3. The upper slipper will move well to the right in its slot, while the lower slipper will rise slightly. To accommodate this movement, the disk must turn to the position shown. Using compass and triangle to draw in the disk after the crank position has been set at 30 deg. right, it will be found that the disk



Figs. 2 to 8—Drafting-board demonstration of fact that rotation of driven shaft is half that of driving shaft

must be turned exactly 15 deg. to the right to allow the slippers to stand as shown.

Turning the cranks 60 deg. will carry the disk 30 deg. as shown in Fig. 4. In the same way construction of Figs. 5, 6, 7 and 8 will prove by actual measurement on the drafting board that, whatever the angle through which the driving shaft is turned, the driven shaft turns exactly half that angle in the same direction. Thus uniform rotation of the driving shaft must produce uniform rotation of the driven shaft at half speed.

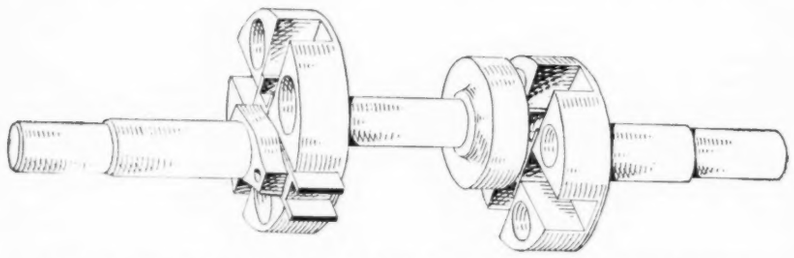
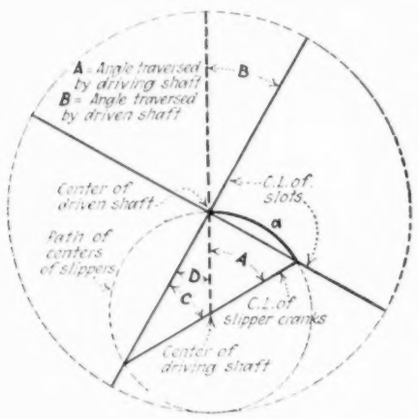


Fig. 9—Double unit. Center shaft turns at half-speed and right shaft at quarter-speed

While this drafting-board demonstration is satisfactory for practical purposes, a brief geometrical demonstration is given in Fig. 9 for those who prefer this to empirical proof.

For practical operation this unit is housed and runs in a bath of oil to assure constant and ample lubrication of the slippers.



Proof that $B = \frac{1}{2} A$

$C = \frac{1}{2} A$ because A and C both intercept the same arc a, but A has its apex at the center of the circle and C on the circumference

$C = D$ because they are two base angles of isoceles triangle with radii for equal sides

$D = B$ (vertical angles)

Therefore $C = B$

And $B = \frac{1}{2} A$

Fig. 10—Geometric proof that driven shaft turns through an angle half that of driving shaft

The question of friction loss will be raised. While no data on this point are given in the article in *Mechanical World*, it seems reasonable to conclude that the friction would make the efficiency of this drive fall below that of well-cut gears. The latter, as is well known, is often close to 100 per cent. It should be noted, however, that the slipper doing the more work has always the lesser movement, which fact tends to reduce losses of power caused by friction.

For example, in Fig. 2 the lower slipper is doing all the driving and none of the sliding, while the upper slipper is sliding rapidly but doing no work. In Fig. 3 the lower slipper is still doing most of the work but sliding slowly, while the upper is beginning to slow down and take on part of the driving load. In Fig. 5 the rate of sliding and the work are equal for both slippers. This continues until, in Fig. 8, the former bottom slipper is at the top, sliding rapidly but doing no work, while the (now) lower slipper is carrying the entire drive with no slipping.

The most obvious drawback of this simple unit as shown is that it permits of but one speed ratio—two to one. By putting the units in series as shown in Fig. 10, a four-to-one ratio is obtainable, the middle shaft turning at half the speed of the driving shaft and the driven shaft (right) at half the speed of the center shaft. Three units in series give an eight-to-one reduction, four units a sixteen-to-one reduction, and so on.

Special Change Speed Gears

It might appear impossible to combine these units in such a way as to permit other speed-reduction ratios than those which are a multiple of two, or to produce a reverse gear. This has, however, been accomplished by a highly ingenious system of clutches, cranks, cams, etc. For example, a planer drive has been designed which, by the throw of a single lever to different positions, will give a slow cutting speed, a fast return or a "neutral." It is also possible, by the use of slipping clutches, to get reduction ratios falling between the fixed ratios of two, four, etc. These intermediate ratios, dependent as they are on slipping clutches, are not positive.

It would take more space than is available to explain the mechanisms for reversing, changing ratios, etc., but it is hoped that operation of a simple unit or of two or more such units in series has been made perfectly clear.

It should be noted that in case of a double reducing unit, the offset of the shafts being the same in both steps, the driven shaft can be placed exactly in line with the driving shaft if so desired. Evidently, it is also possible so to arrange the bearings that the driven shaft may be offset from the driving shaft by any distance up to twice the throw of a single crank.

Governing a Large Hydro-Electric System

In a paper, "Practical Aspects of System Stability," by Roy Wilkins, presented before the Midwinter Convention of the American Institute of Electrical Engineers, the author said, in reference to the system of the Pacific Gas & Electric Co., that experience has demonstrated that for a load of 300,000 kw., a drop from 60 cycles to 59 cycles will drop the load about 3.5 per cent, while an increase of from 60 to 61 cycles increases the load about 4 per cent. This is due to the character of the load, some of which varies with the cube of the speed and some of which has no variation with speed. The actual percentages vary slightly therefrom with the season. The network is somewhat self-governing and the actual governing is done on one unit in a designated plant with all the remaining plants carrying block loads.

There are two methods of accomplishing this result:

1. Setting all governors on a flat speed characteristic to reject load at approximately ½ cycle above normal speed with a load limit set for a block load on all but the one governor used for regulation on turbines or a given nozzle opening on impulse wheels. Then as the speed varies too near the limit of the governing unit, add to or reduce the block load to keep the governing unit in action.

2. Set all governors with a drooping speed characteristic and change the governor setting as load increases or decreases in the manner of the synchronizing motor on a steam turbine.

The Pacific Gas & Electric Co. network uses the first on hydro-units and the second on steam, although various combinations have been used in the past.

On the network with the present system of relaying, the speed does not drop enough during switching or trouble for the governors to act until after the switching is over. This is true for several reasons:

First, it is not possible to deliver sufficient kva. at any given point in the network to drop the speed fast enough to get governor action during the time it takes to clear trouble.

Second, governors, particularly on hydro units, have an operating time determined by the equipment controlled, such as, turbines, relief valves and penstocks, and this is of necessity a matter of several seconds.

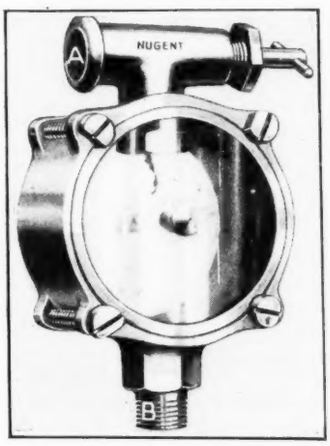
All governors in general use today are used for holding speed and nothing else, and are, therefore, of necessity actuated only by speed. Particularly on hydro-electric units not having a means of bypassing the unit, the governors are definitely limited in action by penstock pressure rise, and are therefore a compromise between the cost of generators to stand overspeed and overvoltage and penstocks to stand overpressure.

Where work is produced by expanding steam, the loss of heat per pound of steam is theoretically equal to 2,545 divided by the number of pounds of steam used per hour per horsepower generated.

New and Improved Equipment

Nugent Adjustable Sight-Feed Valve

A sight-feed valve, having a clear vision of three inches and one that can be set at any angle most advantageous to the engineer, independent of the position of the valve or run of feed



Sight feed valve for large bearings

pipe, has been brought out recently by Wm. W. Nugent & Co., Chicago, Ill.

The feed valve is clamped in the desired position by means of a clamping nut which, owing to size of the glass holding frame, can be turned with any ordinary type of wrench, no special tool being required. The glass is readily removed for cleaning or clamping the valve in position by turning the flat side of the four screws inward.

In addition to the type shown in the illustration, valves in which the inlet *A* enters through the top or a valve with a threaded opening in the top for an emergency oil cup or other means of supply may be furnished as desired. The valves are furnished with the inlet at *A* $\frac{3}{8}$-, $\frac{1}{2}$- and $\frac{3}{4}$-in. pipe sizes and the shank at *B* not less than $\frac{1}{2}$-in. pipe thread.

Engelhard Type S Recording Pyrometer

The Charles Engelhard Inc., 30 Church St., New York City, has recently brought out the type S recording pyrometer illustrated in Figs. 1 and 2, in which have been embodied a number of improvements, principal among these being the mercury contact switch shown in Fig. 3.

The outer case of the instrument is made up of two castings, the back half, which forms the base of the instrument, being made from cast iron and the front half or cover, from cast aluminum. The mechanism is assembled on a sub-base that is secured to the casing by four bolts.

The galvanometer-moving system which is mounted on the back of the sub-base responds to the electromotive force applied to the terminals of the instrument, and its deflection from the low-scale division is a measure of the electromotive force, which in most cases is calibrated directly in terms of temperature. The clock mechanism drives the chart at a fixed rate of speed. A depressor bar above the pointer is operated intermittently from the power unit. When the depressor bar is lowered, the pointer presses the inked ribbon against the chart and records the pointer's position.

The power unit is controlled from a contact switch mounted on the clock. Each time that a circuit is established through this contact switch, the power solenoid is drawn down and drops the depressor bar against the pointer.

The recording chart is of the ribbon type and approximately 100 ft. in length, the over-all width of the chart being $6\frac{3}{8}$ in. The chart is held against the driving drum by a series of rollers that are mounted in a separate frame, hinged so it can be swung outward while the rolls are being changed. The

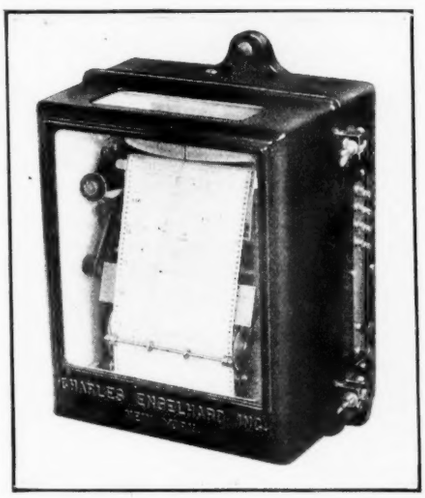


Fig. 1—Type S recording pyrometer

driving drum for the chart is connected to the gear train by an adjustable clutch, which is designed to relieve the clock gears of any undue strain. The printing bar is located so that the record of the instrument can be seen as soon as it is made.

In the case of a single-point recorder where there is no distinction in color, a one-color ribbon is used. On multiple-point instruments with color distinction, a ribbon $1\frac{1}{2}$ in. in width, with parallel color stripes, is furnished.

The electric clock for the unit is designed for alternating current and is of the Warren type. The mercury con-

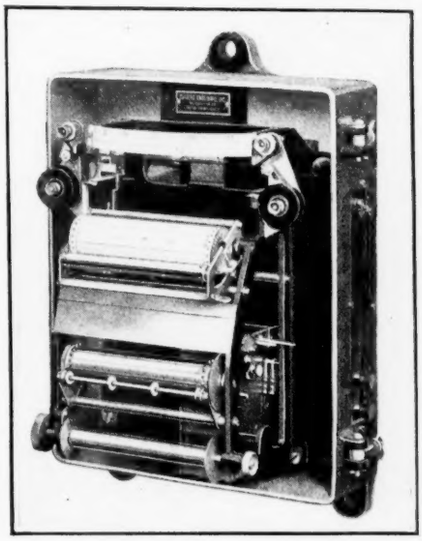


Fig. 2—View of pyrometer mechanism

tact switch previously referred to is furnished on multi-record instrument and forms part of the power unit. The switch consists of levers mounted on a spindle and spaced from one another. To the lower ends of the levers is attached a small glass tube containing

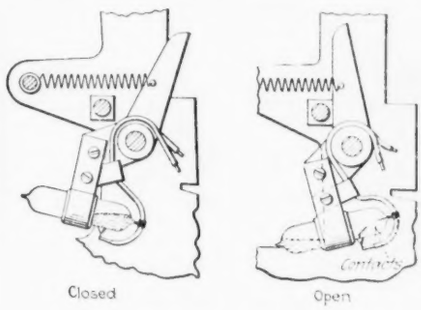


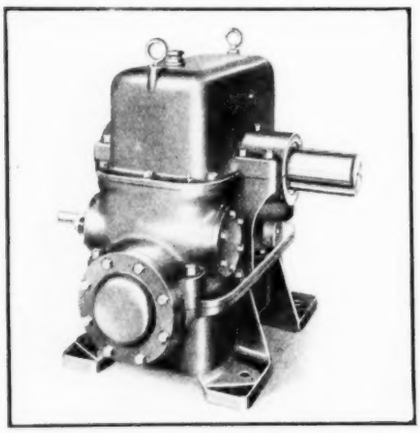
Fig. 3—Mercury contact switch

mercury and sealed in electrodes. The normal position of the levers is such that the bulbs are tilted and the mercury is not in contact with the electrodes. Opposite each lever on a revolving spindle that is connected to the pinion of the power unit, is a stud that throws the lever forward when turned to the right position. This action tilts the switch bulb so that the mercury completes the circuit between the two electrodes as shown in the closed position, in Fig. 3.

De Laval Speed-Reduction Units for High Ratios

To meet the demand for a speed-reduction unit for ratios above 100 to 1 and where an extremely wide range of speed is required, the De Laval Steam Turbine Co., Trenton, N. J., has brought out the two-stage worm reduction gear shown in the illustration.

The two wormshafts are carried on ball bearings and the low-speed shaft on sleeve bearings. The lower part of



Reduction units for high ratios

the casing forms the oil reservoir, the oil being carried sufficiently high to touch the high-speed wheel and low-speed worm. In addition, a gear-type oil pump directly connected to the end of the lower wormshaft forces oil through passages in the casing to the low-speed shaft bearings. The worm-wheels used are of the renewable rim type, similar to those used in other types of units made by this company. To avoid end thrust, connection between the driving and driven machine is made by means of flexible couplings of the pin and rubber bushing type. The units are being built for ratios up to 8,000 to 1.

Two-Ton Automatic Juruick Refrigerating Unit

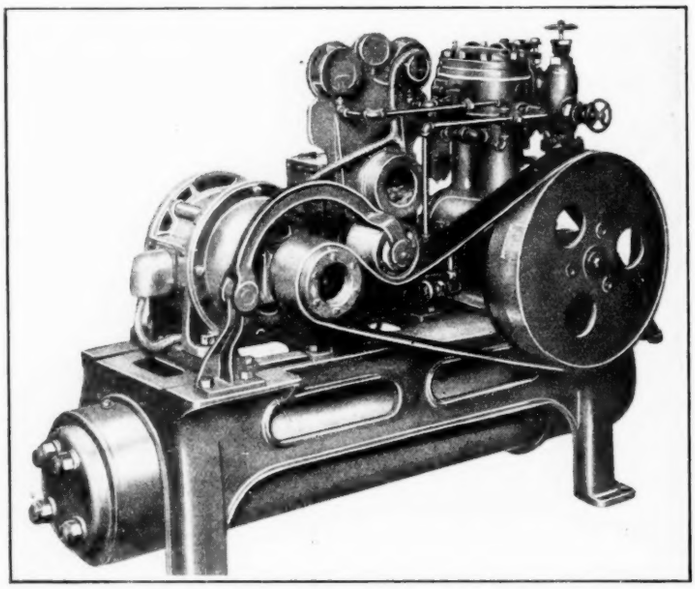
A self-contained refrigerating unit designed especially for automatic operation is a recent addition to the line of Juruick refrigerating machines manufactured by the American Engineering Co., Philadelphia, Pa.

The unit, which is built in 2-ton capacity, includes motor, compressor, condenser and ammonia storage tank mounted on one base and equipped with all the necessary controls. All working parts are readily accessible for inspection and repairs.

The water jacket of the compressor is cast integrally with the cylinder and is made of large capacity to provide ample cooling with a minimum of water. A special type of metallic packing designed to give an oil seal against gas leakage is used on the compressor.

A bypass valve is provided to obviate starting against compression and prevent belt slippage and overloading of the motor when starting. The condenser is of the shell-tube type and is made readily accessible for cleaning. The machine is driven by an alternating- or direct-current motor as required, through a belt running over a ball-bearing idler.

The protective and automatic control devices include an automatic starting box, with device for shutting off the current in case of overload; thermostat for starting and stopping the machine as cooling conditions require; automatic water regulator operated by the ammonia pressure to control the flow of water through the condenser; low-water safety stop, and a high-pressure stop to shut off the current from the motor in case the ammonia pressure mounts too high.



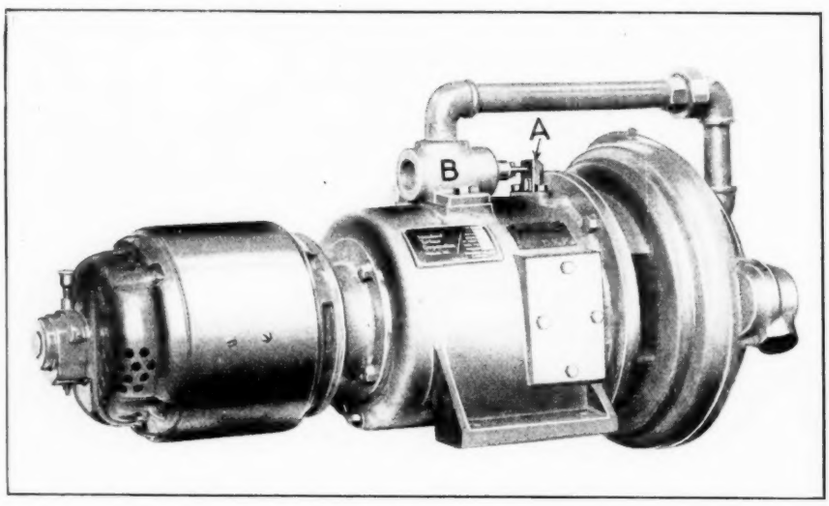
Refrigerating unit designed for automatic operation

Standard Turbine Corp. Emergency Lighting Unit

A turbo-generator set in sizes from ½ to 10 kw., designed especially for use as an emergency lighting unit for the power station, is a recent development of the Standard Turbine Corporation, Scio, N. Y. The unit is arranged to start automatically when for some reason the regular light supply on the station fails, automatic starting being accomplished by means of an electrically operated shuto.' valve in the turbine steam line.

The set is similar in construction to the regular line of small lighting sets built by this company except for the governor, which is of special design and which operates in the oil space of the bearing pedestal. The steam governing valve *B* is fastened directly to the top of the turbine and connects with the governor through the lever *A*. The generator is made an integral part of the turbine, which tends to reduce the over-all size of the unit for a given capacity.

Code on Definitions and Values. Power Test Codes, A.S.M.E. 1923. Published by the A.S.M.E., 29 West 39th St., New York City. Price 50 cents to members and 55 cents to others.



Emergency light unit designed for automatic starting

Oil as a Boiler Fuel*

Some Suggestions on Installation and Operation and the Purchase of Fuel Oil

By ALLEN F. BREWER†

WHEREVER fuel oil is to be used as stationary boiler fuel, it must be fired with a maximum of care and economy. In effect one must heed such facts as:

1. The proper preheating of the oil prior to firing.
2. The cleanliness of both boiler and furnace to insure a maximum of heat transfer.
3. The reduction of air leaks in settings or around boiler headers.
4. The accurate control of the air required for combustion.
5. The prevention of oil leaks prior to delivery of the fuel, or within the furnace, from faulty joints, burner tips, etc.

Lack of observance of any of the foregoing will tend to reduce the unit evaporative power of the oil and, if allowed to continue, will necessitate the firing of additional fuel to meet the steam requirements.

Preheating the Oil

The extent to which fuel oil should be preheated will depend largely upon the viscosity and gravity. As a rule, the heavier or more viscous the oil the higher should be its firing temperature in order to insure effective pumping and atomization. In the case of crude oils such as certain heavy Mexican varieties, or topped crudes that originally contained a relatively low percentage of lighter fractions, such as gasoline and kerosene, the requisite temperature may often be considerably above the flash point. For example, an oil of from 10 to 12 deg. Baumé gravity may require heating to the neighborhood of 200 to 300 deg. F. Owing to the low proportion of lighter products present, however, which would tend to flash at lower temperatures, the possibility of any fire hazard being involved is relatively remote. As a rule, flashing will be prevalent only in proportion to the rate at which these more volatile constituents are freed from the surface of the oil. Therefore, there will be but little possibility of the entire volume of the oil flashing simultaneously. It will, as a rule, be advisable to experiment some to determine the proper degree of preheating.

Relatively new grades of fuel oil have been developed in connection with new processes of handling and refining, which run comparatively low in Baumé gravity and low in viscosity. A recent analysis of an oil of this character indicated a Baumé gravity of approximately 15 deg. and a viscosity at 122 deg. F. of approximately 200 sec. Saybolt Universal. This would indicate a fluidity at normal temperatures of an ordinary machine lubricating oil. It can be appreciated therefore that such a fuel oil would not require nearly as much preheating as a more viscous residual product of approximately the same Baumé gravity.

Atomization and the ease with which the oil can be pumped are general indications to the correct degree to heat a fuel oil. Too low an oil temperature will tend to preclude effective atomization and render pumping of heavier oils relatively difficult. Such products, if too sluggish, may flow intermittently and cause a decrease in fuel delivery to the burners. Other frequent results of insufficient heating may be the development of excessive smoke due to incomplete combustion and the possibility of clogging the burner tips.

Too high an oil temperature, on the other hand, may give rise to carbonization within the burner or oil lines, and unsteady burning due to pulsation.

As a rule, steam is the heating medium. In many cases, especially where higher-gravity oils are being used, it will be practicable to employ exhaust steam for this purpose. With oils requiring a firing temperature above 200 deg. F., it has been found best to use live steam. With an effective type of fuel-oil heater of the double-pipe-coil type, multi-pass, or film type, etc., a minimum of steam will be required, and the cost of preheating reduced to a negligible factor in comparison with the fuel economies and increased efficiency that are made possible.

Cleanliness of Boiler and Furnace

In the attainment of maximum fuel economy cleanliness of both the furnace and boiler heating surfaces is another important factor. To be sure, the possibility of marked accumulations of dirt and soot will be less than when firing solid fuels. Furthermore, there is no ash to contend with. But these facts will frequently lead to carelessness and the mistaken impression that cleaning boilers is of more or less minor importance. Soot accumulations on the fire side of boiler heating surfaces, as well as possible water deposits within, must be corrected else the rate of heat transfer and evaporation will probably be reduced to a marked degree.

The frequency of furnace cleaning will depend to a large extent upon the rate of firing and the degree to which the oil is atomized. Imperfect atomization or the firing of globules of oil too large or heavy to be completely burned will result in coking, especially on the checkerwork below the burners due to accumulations of unburned fuel. Not only will this mean a direct loss in heat units, but also the clogging of the air spaces in the checkerwork. Naturally, this will reduce the size of the appertures through which air for combustion can penetrate (especially in a steam or air atomized system) with a consequent reduction in the rate of evaporation per pound of oil fired.

Hard firing under higher overloads will tend to cause damage to brickwork and boiler settings, especially if a type of burner is used that is capable of throwing a relatively long flame. Impingement of this latter on the brickwork will exert more or less of a blowtorch action. Ultimately, this will tend to damage the brickwork. Too long a flame in company with imperfectly atomized oil may also result in coking or carbon deposits on the brickwork. For these reasons the furnace should be examined at regular intervals.

Control of Air and Reduction of Leaks

Perhaps the most prevalent cause of reduced boiler efficiencies when burning fuel oil is the admission of too much excess air either intentionally or through leaks in the boiler setting. This will be indicated by low CO_2 readings in the flue-gas analysis; for, although low CO_2 may also be due to the admission of too little air or improper mixing of this latter with the gases of combustion, as a rule too much air is the more probable explanation.

Oil Leaks

Leaks from burner tips, pipe joints, fittings, heater connections and pumps must also be guarded against, for they will mean not only a direct waste of oil, but also a distinct fire hazard. Where oil piping is located in trenches, underground (as from storage tanks) or elsewhere in darkened or obscure parts of the plant, leaks may continue unobserved for some length of time, especially if on the tank side of the oil meter, provided one is installed. Occurring from parts of the system between the meter and boilers, however, they will be indicated, even if in no visible manner, by a low resultant evaporation.

As a rule, fuel-oil leaks will ultimately show up in the form of drippings, oozing out on to the surroundings, or discoloration of the adjacent earth. Oil does not easily disappear, even if leaking directly into waterways or ditches, and there should be little difficulty in determining that leakage is taking place and tracing this to the point at fault.

Certain grades of oil give off appreciable vapors which are heavier than air and will tend to collect in the lower levels unless these are thoroughly ventilated. Frequently, the periodic hosing down of the boiler room will free all drains of such vapors, but it should never be depended upon. There is too great a possibility of the vapors lurking untouched, to become a potential hazard in case of exposure to a naked flame.

The tendency to impose undue limitations in the writing of fuel-oil specifications often defeats the object in view.

†Mechanical engineer, The Texas Company.

*Abstract of paper presented at the Midwest Power Conference.

In consequence, frequently certain grades of oils that are well suited to the requirements may be excluded by an unwarranted specification as to fire point or calorific value. In fact, the purchaser, by such a procedure, will frequently not only limit himself to unnecessary expense and difficulty in the obtaining of his fuel, but in addition will confine the oil marketer to limitations that may today be difficult to bid on. A broader viewpoint is needed as to fuel-oil specifications, and a greater degree of confidence in the ability of the marketer is warranted.

In brief, the gist of the specifications should be: Will the oil meet conditions in the plant? Will it pump freely when subjected to normal heater capacity? Will it atomize properly at this temperature when passed through the burners? These are more important than idealistic figures as to fire point, sulphur content and calorific value. Those of us who have fired low-gravity still bottoms, products that frequently run heavier than water and that require heating to 300 deg. F. or above, know how practicable it is to attain effective atomization and an evaporation in the neighborhood of 14½ lb. of water per pound of fuel, notwithstanding such products have a comparatively low calorific value and often run high in sulphur.

The same holds true for heavy Mexican crude oils. Their fire point is often well under the temperature necessary for preheating; they run high in sulphur and low in heat value. Yet they give the results and approximate the ideal nearly to the same extent as a high-gravity Navy grade of fuel oil.

One must also take the kind of burners into account. Mechanical burners of the marine or stationary type with relatively small burner orifices, and others subjected to ordinances or rules concerning the maximum degree of preheating will require more attention to gravity and viscosity than will some of the more simple installations.

The better procedure would be to discard that specific mandatory attitude in which so many enter the oil market, presenting instead the conditions and requirements before the reputable oil marketer for advice. It is not the object of the latter to sell a rarity, or the highest-priced fuel possible. He would be losing out in the long run, for ultimately the purchaser would be bound to see the light and realize that specifications are secondary to information regarding actual operating conditions, the design of the system and the results desired. The logical result would be that the purchaser would then turn to a more scrupulous dealer whose aim is future business and repeat orders rather than a desire to sell higher grades of oil than conditions warrant and at higher prices.

The essential fact for the purchaser to remember is that the reputable oil marketer today is usually an expert. "Necktie salesmen" don't sell fuel oils. Sound out the next fuel oil marketer you meet and you'll probably find he is a graduate engineer, perhaps holding a marine or a stationary license, and with a knowledge of combustion which you would do well to take advantage of.

Flue-Gas Stops Dust Explosions

Engineers of the United States Department of Agriculture have erected a feed-grinding mill at the experimental farm, Arlington, Va., to demonstrate the practicability of using inert gas from boiler flues for preventing dust explosions. A regular feed-grinding unit for grinding oat hulls has been installed, and a pipe line from the power house brings in the flue gas.

Many dust explosions in feed-grinding mills originate at the point where the grain enters the grinding machinery. They are due to the presence of dust and its ignition by sparks which are often caused by such foreign materials as pebbles or pieces of metal coming in contact with the steel grinding plates. If dust is present, a small explosion at the grinder may spread in successive explosions of increasing size throughout the milling system. Consequently, it is extremely important to prevent these preliminary explosions.

Dust explosions can occur only when sufficient oxygen is present and other conditions are favorable. Tests have shown that explosions cannot occur in an atmosphere containing less than 13 per cent oxygen. By the introduction of flue gas, or carbon dioxide, in sufficient quantity explosions will be prevented.

Although this mill is equipped for grinding oat hulls for stock feed, the principles involved in preventing explosions by means of inert gas are applicable to mills that grind many other materials. The department is anxious that mill owners, operators and others interested in dust-explosion prevention visit the experimental mill and observe some of the tests.

Firing with Natural Gas

In California there is being produced some eighteen billion cubic feel of natural gas per month. This gas, which has a heat content of 1,200 B. t. u. per cu. ft., is equivalent to approximately 3,300,000 bbl. of oil. A large proportion of this gas is used as fuel in boiler plants.

There are a few precautions that must be kept in mind when burning natural gas under boilers. One is the necessity of having all the gas feed lines properly drained. At the lowest points of these lines drip valves should be placed, and these valves should be periodically blown out. There is formed in the lines, an asphaltum condensate which drains to the lowest points of the lines, and which, if allowed to collect without being removed, will reduce the effective area of the lines and cut down their carrying capacity. In addition to such reduction in line capacity, the presence of this condensate in the lines to the burners constitutes a serious hazard in that it sooner or later carries over into the burners and may extinguish the flames. In several instances this has occurred and has resulted in serious furnace explosions, due to the accumulation of gas and air in explosive mixture, being ignited by the heated brickwork of the furnace walls.

Another precaution to be taken in the use of natural gas as a boiler fuel is the maintaining of a constant and adequate pressure of gas. This is important if constant and efficient operation is to result. It is highly important that the proper amount of air be mixed with the gas in order that complete combustion may result and the maximum amount of heat be secured from such combustion.

Production of Bituminous and Anthracite Coal

Bituminous 1919-1925

In Thousand Net Tons

	1925	1924	1923	1922	1921	1920	1919
January	51,930	52,507	51,944	38,930	41,148	49,748	42,193
February	38,987	47,302	43,645	42,425	31,524	41,055	32,103
March	37,626	41,288	48,446	51,936	31,054	47,850	34,293
April	33,702	30,429	44,057	16,335	28,154	38,764	32,712
May	35,474	32,276	47,690	21,005	34,057	39,841	38,186
June	37,167	31,458	47,083	23,096	34,635	46,095	37,685
July	39,582	33,346	46,707	17,602	31,047	45,988	43,425
August	44,883	35,923	50,578	26,755	35,291	49,974	43,613
September	46,817	42,376	47,841	42,463	35,870	50,241	48,209
October	53,203	48,414	50,907	46,733	44,687	53,278	57,200
November	50,780	42,102	44,425	46,900	36,805	52,576	19,006
December	52,816	46,266	41,242	48,088	31,650	53,257	37,235
Total—Year	522,967	483,687	554,565	422,268	415,922	568,667	465,860

Anthracite 1919-1925

In Thousand Net Tons

	1925	1924	1923	1922	1921	1920	1919
January	7,419	7,724	8,521	6,566	7,681	7,459	7,819
February	7,176	7,428	7,602	7,096	7,983	6,415	5,102
March	7,040	7,908	9,175	9,181	7,677	7,935	5,190
April	7,253	6,639	7,885	27	7,985	6,285	6,884
May	7,898	7,549	8,384	36	7,752	8,037	7,525
June	7,576	7,509	8,474	86	8,071	8,251	7,404
July	8,293	7,584	8,136	118	7,309	8,342	7,974
August	8,966	6,906	8,672	164	7,459	8,105	8,096
September	52	7,408	2,853	5,075	7,385	4,691	7,494
October	68	7,479	8,532	8,896	7,858	8,148	8,645
November	151	6,504	7,575	8,695	7,110	7,527	7,870
December	224	7,189	7,530	8,743	6,203	8,403	8,089
Total—Year	62,116	87,927	93,339	54,683	90,473	89,598	88,092

News in the Field of Power

Three Large Corporations Backing N. Y. State Power Projects on St. Lawrence

The Aluminum Company of America, E. I. du Pont de Nemours and the General Electric Co. Are Behind Licenses Desired by Smaller Companies

THE Aluminum Co. of America, E. I. du Pont de Nemours & Co. and the General Electric Co. are the actual controlling powers behind the corporations seeking hydro-electric grants from New York State on the St. Lawrence River, according to official revelations made on Feb. 25 at a hearing before the State Water Power Commission.

The commission refrained from taking any action on these applications beyond reviving temporary permits, which had been annulled while the commission was under Democratic control during 1923 and 1924.

On a similar application for a 300,000-hp. development on the gorge below the falls at Niagara, in which the principal was the Lower Niagara Power & Water Supply Corp., action was deferred.

This was an application for a temporary permit which carried with it a condition that it must be definitely accepted within thirty days. The company has never complied with this requisite, but the application has been kept alive awaiting action by the applicant.

The commission, on its own initiative, extended the time further, to afford the state an opportunity to investigate the attitude of the federal government, which may have an interest in the leasing of power sites on this boundary stream, where the use of water is controlled by stipulation contained in treaties on the subject, which have been made with Great Britain.

Real Applicants Revealed

George T. Bishop, president of the Frontier Corp., a holding company, controlling the Louisville Power Corp. and the St. Lawrence Valley Power Corp., who so far have been the visible applicants for the St. Lawrence River concessions, read into the record a statement in which it was set forth that the Frontier Corporation in turn was controlled by the Aluminum Co. of America, E. I. du Pont de Nemours & Co., and the General Electric Company.

He declared the du Ponts were not now actively interested in the proposed St. Lawrence development since they had gone to West Virginia and established a plant not dependent on water power for the production of nitric acid from nitrogen in the air.

The General Electric was interested in power development because it manufactures equipment used in the production and distribution of hydro-electric energy. Aluminum was now used to a considerable extent in the place of copper in the transmission of power over long distances.

Colonel Hugh L. Cooper, who built the government dam at Muscle Shoals and is regarded by engineers as the greatest expert on hydraulic construction in the United States, was the chief witness. He asserted that it would cost the State of New York twice the amount, possibly more, that it would cost private interests to develop its unharnessed water power resources.

He declared that water power development should be removed from politics and sounded a warning that unless something was done to harness up the state's remaining water power resources, which he said amounted to approximately 3,100,000 hp. industries would leave the state and go elsewhere where power was available. Some had already gone to Pennsylvania, where there was cheap coal, some to West Virginia and other Southern States or to the Dominion of Canada, where there was cheap hydro-electric power.

Colonel Hugh L. Cooper talking on the development of the St. Lawrence said:

> The St. Lawrence River presented the greatest possibilities for power development in the world. Unity of control of what was done on the St. Lawrence was essential to success of the development. It would be possible to develop some 5,400,000 hp. on this boundary stream, but the best sort of development would call for more engineering skill than any project in all the history of man.
>
> Two things must be considered—power development and navigation. Each must be promoted without working injury to the other. Development in order to be successful would require the fullest sort of cooperation between the Canadian Government and authorities on the American side of the river.
>
> I've got horse sense enough to know, however, that we can never accomplish anything when we have one fellow here in New York State who says, "Let's do it my way" and another in Canada who wants to do it his way, and Washington with some other and entirely different idea. We must remember that the Lord made the St. Lawrence River in one piece, and for that reason you have to treat it as a unit. For instance, you cannot have one-half of a dam built Canada's way and the other half built our way and neither can build clear across the river, as we must.
>
> Colonel Cooper then reverted to the undeveloped power resources of this State. "It would save the consumers more than $105,000,000 a year if they were harnessed up," he said. "It would save annually about 25,000,000 tons of coal. That amount of coal would fill a freight train 4,000 miles in length. Development would release to the railroads $350,000,000 worth of equipment ordinarily used for hauling coal. Because New York cannot settle this question, great industries are not coming here but going to other states."

Muscle Shoals Consideration Again Delayed

Delay in disposing of the Aluminum Company controversy made it impossible for the Senate leaders to bring up the Muscle Shoals resolution the first of the week as had been arranged.

As this is written prospects seem to favor the passage of the House resolution, but a determined effort will be made to amend it. The principal amendment sought is to provide for more than one lease and for the distribution of such power as may not be needed for fertilizer production. There is a growing sentiment in the upper chamber against disposing of the birthright until a better measure of its value will have been obtained.

New York Edison Gives Out Figures to Commission

At a hearing held on Feb. 24 by the New York State Public Service Commission on the complaint filed by the City of New York in 1923 against the rates charged by the New York Edison Co., Henry M. Edwards, vice-president of the company in charge of accounting, submitted figures showing some of the expenses and revenues.

The company spent, it was disclosed, in 1924, $801,264.47 for regulatory commission expenses; in 1925 this expense grew to $2,647,869.04. An exhibit disclosed that in these two years the company spent $2,834,930.10 for engineering and clerical services. In the two years the company paid Francis Blossom, an engineer, and the engineering staff of Sanderson & Porter $270,134.99. For appraising land owned by the company J. P. Day received $10,000 in 1925.

Legal services and disbursements in the rate litigation for the two years cost the company $63,664.25. There was also an item of $29,486 for sundry expenses and supplies connected with the suit.

Mr. Edwards testified that in 1925 the company sold 1,237,980,793 kw.-hr. of electric current at a net cost of $44,641,394.64. The revenues of the company amounted to $57,511,754.39, which made the net earnings of the company $12,870,359.75, or 5.35 per cent on the company's investment.

John J. Ryan, superintendent of power, was cross-examined by Assistant Corporation Counsel Morrissey, concerning the cost of generating current.

Wages paid by the company to foremen, assistant engineers and timekeepers were nearly double the wages paid for similar work by other corporations, it was said.

Uncollectable bills amounted to $162,497.19 in 1925. The value of property retired from service in 1925 represented an investment of $1,816,271.84. The hearing was adjourned without date.

Settlement of Great Lakes-St. Lawrence Power and Navigation Project in Sight

Correspondence Between Great Britain and United States Made Public—Secretary Kellogg Upholds Chicago Diversion

EVENTS are moving toward negotiation of a comprehensive settlement of Great Lakes and St. Lawrence River navigation and power disputes between the United States and Canada and an agreement on co-operative undertakings of vast magnitude to develop and conserve these water resources. This fact developed on Feb. 24 following issuance by the State Department of the diplomatic correspondence between the United States and Great Britain occasioned by Canada's protest against the War Department permit to the Chicago Sanitary District to divert 8,500 cu.ft. of water per second from Lake Michigan, according to the *New York Times*.

Canada Insistent Regarding Chicago Diversion

In this correspondence Canada not only hinted at demands that may be made on the United States for alleged damage to Canadian navigation and power interests from the reduction of lake levels, and the St. Lawrence River flow, attributed to the Chicago diversion, but threatened to block the St. Lawrence seaway project unless the withdrawal of Lake Michigan water were reduced to a fraction of the present volume.

The United States consented to include the question of the Chicago diversion in the consideration of the engineering problems of the St. Lawrence seaway, and the Administration now views with favor the negotiation of an agreement with Canada covering the entire group of related questions pertaining to joint use of the Great Lakes and the St. Lawrence River by the two countries.

Scope of Proposed Agreement

The contemplated understanding would embrace the following matters:

1. Construction of the St. Lawrence seaway, enabling ocean ships to penetrate to all of the Great Lakes and development of the incidental water power by the United States and Canada, as a joint undertaking, at a cost now estimated at $275,000,000.

2. An accord on the conservation of lake levels, involving an authoritative ascertainment of the climatic influences, a revision of the treaty authorizing Canada to divert 36,000 and the United States 20,000 cu.sec. ft. at Niagara Falls, an agreed restriction of the diversion at Chicago and the Welland Canal, and compensating matters in the St. Claire and Niagara Rivers to offset lake withdrawals.

3. Preservation of the scenic beauty of Niagara Falls by the construction of concrete islands in the Niagara River so as to retard, by deflection of the current, the gradual destruction of the falls by erosion. As a result of the present course and velocity of the current the crest of the falls has been worn back 110 ft. in nineteen years, causing geologists to predict that ultimately Niagara may cease to be a waterfall and become merely rapids.

The dispute over the Chicago diversion is now at a standstill, each Government standing its ground. All the correspondence was made public Feb. 24 as the result of a demand in the Canadian Parliament and by agreement between the two governments. It is quite voluminous.

Just before the present permit for 8,500 cu.sec.ft. was issued on March 3 last by Secretary Weeks, Canada expressed the hope that the diversion would be limited strictly to the essential health requirements of that city, and after the permit was issued expressed surprise at the doubling of the permitted flow and inquired whether the newly authorized diversion represented any reduction in the actual flow in recent years to which was attributed, in large part, the fall of the lake levels.

Secretary of State Kellogg replied that the 1924 diversion was 9,700 cu. sec.ft. and that the average flow would be from 1,750 to 3,000 cu.sec.ft. less by 1929.

Canada was not satisfied with this explanation and injected the interpreted threat to halt consideration of the St. Lawrence seaway project.

The final note in the series made public, Feb. 24, was Secretary Kellogg's rejoinder of Nov. 24, 1925, in part, as follows:

> In the judgment of the Secretary of War the average diversion which should be authorized for sanitary purposes under the conditions known to exist, should be not less than 8,500 cu.ft. per second.
>
> The safety of the lives and health of citizens of the locality cannot be disregarded, and until the conditions of the permit of March 3, 1925, have been complied with, no substantial reduction in the amount of diversion could be made without endangering health if not life.
>
> The deepening of the Little Calumet River will give the Sanitary District of Chicago better control over river reversals, for it will increase the discharge capacity of the system at intermediate stages and insure protection of the water supply during these critical periods.
>
> The Canadian government is correct in concluding that no immediate reduction in diversions has been provided, but its conclusion that no definite reduction is assured and that the effect of the permits will actually be to authorize a greater diversion than is now being made cannot be confirmed. The gross flow at Lockport will not exceed an average of 9,700 cu.sec.ft. and by the time the permit of March 3, 1925, has expired the gross flow may be reduced to 8,000 cu.sec.ft. and probably to 6,700 cu.sec.ft. The sewage treatment program of the sanitary district has been arranged, so as to make it possible to effect a reduction to a gross flow of 4,167 cu.sec.ft. by the year 1935, or before.

Junior Engineers Needed by Government

The United States Civil Service Commission announces an open competitive examination for junior engineers, the receipt of applications closing on April 17. The examination is to fill vacancies in various branches of the government service throughout the United States. The following subjects are included: Aeronautical, agricultural, ceramic, chemical, civil, electrical, explosives, highway, hydraulic, industrial, irrigation and drainage, materials, mechanical, mining, naval architecture and marine, petroleum, radio, and structural engineering, and fuel combustion. Information and blanks can be obtained from the Civil Service Commission in Washington, D. C., or examiners at the post office or custom house of any city.

Junior Mechanical Engineers Wanted by Chicago

On March 22, at 9 a.m., the Civil Service Commission of the City of Chicago will hold an examination for junior mechanical engineer, Branch II, Class D, Grade 3; salary, $2,460-$2,760. Those desiring to take this original entrance examination must file applications with the Civil Service Commission, 610 City Hall, not later than 5 p.m. weekdays and 12 noon Saturday of the day preceding the examination.

Ottawa River Development Forecast

The development of power at Queenstown, Ontario, having been carried to a successful completion, the Ontario government is now looking for other sources of supply, and is seriously considering the development of a number of water-power sites on the Ottawa River. This point was emphasized in the speech from the throne at the opening of the Legislature on Feb. 10. The speech stated that the government was hopeful of reaching an amicable agreement with the sister province of Quebec whereby the waters of the Ottawa River along the interprovincial boundary will be rendered available for development. The government is also pressing for the recognition of the right of the province to proceed with the initial development of the St. Lawrence River.

Calls Attention of Congress to Coal Commission Report

The *New York Sun*, in an editorial printed on Feb. 25, calls the attention of Congress to the United States Coal Commission Report and the necessity for action by Congress in part:

> The four volumes and atlas which comprise the official report of the United States Coal Commission represent, at a fairly conservative estimate, expenditure of upward of $15,000,000 of public and private money.
>
> That this fact-finding commission under the chairmanship of John Hays Hammond did a splendid job is nowhere disputed. Its investigations were exhaustive and its statements authoritative. Begun in the administration of President Harding the survey occupied eighteen months, during which time competent analysts and statisticians examined almost every question of fact that could conceivably be brought up for legislative consideration.
>
> The whole was finished off with a series of carefully considered recommendations. These have since been approved in main outline by President Coolidge, who has urged upon Congress the necessity for action. Aside from a few desultory bills now lying unregarded in pigeonholes Congress has done nothing about it.
>
> That the present peace is nothing more than a truce is apparent to all who have given it anything but the most superficial attention. As President Coolidge recently said, the coal industry as a whole is facing a situation which threatens economic failure. It is in the power of Congress by statesmanlike action to promote a healthier condition in the industry itself and to safeguard the public interest with which that industry is affected.

Capacity of Venice, Ill., Plant To Be Doubled

The Illinois Power & Light Corp., of Chicago, has purchased a large plot adjacent to its present power plant at Venice, Ill., and contemplates improvements to cost approximately $5,000,000. The capacity of the plant will be doubled by the addition of a 30,000-kw. turbo-generator, and three 15,000 sq.ft. boilers will also be installed. River intakes are nearing completion. The plant will serve the lines of the company between Peoria and Cairo, Ill.

Bartlett's Ferry Plant Progressing

The first unit of the Bartlett's Ferry hydro-electric plant of the Columbus Electric & Power Co. has been put in operation, according to R. M. Harding, manager of the company, and the second unit will follow it shortly. The first unit is furnishing 20,000 hp. and three other units to be installed will also produce 20,000 hp. apiece, making the total capacity of the plant, when completed, 80,000 hp. Actual work on the plant began in July, 1924. The total cost of the project, when completed, is put at $7,000,000.

New Motor Liner Ready for Service

The "Asturias," a 22,000-ton motor liner, built at Belfast for the Royal Mail Steam Packet Co., arrived at Southampton on Feb. 12. The design of the vessel's power equipment has not yet been given out to the public. Two other great motorships are at present under construction—the "Carnarvon Castle," which is being built on the Clyde for the Union Castle Line, and the "Saturnia," which has just been launched at Trieste and will be used on the South American route. The "Asturias" and "Saturnia" will be followed by sister vessels, the "Alcantarna" and the "Urania." Tenders have also been invited for the two new 20,000-ton motorships for the New Zealand service, it is stated in the press.

Naples' New Plant To Be Completed This Year

The Societa Meridionale di Elettricita, of Naples, Italy, is constructing a new power plant at S. Giovanni a Teduccio, a suburb of Naples, state consular advices to the Department of Commerce. When completed, it is believed that the plant will supersede the company's present plant.

The building is being erected on waterfront property which will put it in close proximity to its fuel base. After certain port improvements are completed, the company expects to be able to have a pier and apparatus for the discharge of coal directly from the carrying ships. In the meanwhile oil will be used for fuel. A pipe lined is being constructed to the nearest oil dock, and tanks within the enclosure will store the fuel.

The plant will be finished late in 1926 and is expected to develop 45,000 kw. Later, additional apparatus will be installed to bring the total production to 100,000 kilowatts.

Czechoslovakia Plans Hydro Extensions in 1926

There was increased activity on the part of the government and different municipalities of Czechoslovakia in the development of the water-power resources of the country during the last year. The 1926 program of the Ministry of Public Works includes the completion of the hydro-electric stations in Nymburk, Kolin, Prelouc, and Mirejovice, as well as starting the construction of a reservoir on the Elbe near Verde, and building a dam and a hydro-electric station in Uzhorod. Other work will also be undertaken in various sections of the republic. An appropriation of 25,000,000 crowns has been set aside for this work, according to Consul General C. S. Winans, Prague, in *Commerce Reports*.

Mercury Boiler for South Meadow Station

A significant reference to the possible use of the mercury boiler on a larger scale was made by President Samuel Ferguson of the Hartford Electric Light Co. in his annual report for 1925 to stockholders, as follows: "During the year the General Electric Co. has redesigned the mercury boiler to incorporate such improvements as our former tests showed to be practicable and desirable, including the building of the turbine as a three-stage machine. The redesigned equipment has been in operation at your Dutch Point plant, and we trust that as a result of its operation the General Electric Co. may be in a position to accept an order for a larger installation at the South Meadow station."

The South Meadow's station, it is understood, in process of its redesign will be arranged to try out the use of powdered fuel instead of oil as in the previous arrangement.

Petroleum Production Forecast for 1926

The outlook for United States production of petroleum in 1926, by districts, was summed up in a paper presented before the February meeting of the A.I.M & M.E., Inc., by F. Julius Fohs, consulting oil geologist and vice-president of the Humphreys Corp., as follows:

1. "Likely to increase production—Gulf Coast and Texas, outside of Gulf Coast.

2. "Just maintain present production or decline somewhat—California and Appalachian.

3. "Apt to decline — Mississippi Valley, Rocky Mountain, Kansas-Oklahoma."

It is unlikely, Mr. Fohs predicts, that the Gulf Coast and Texas, outside of the Gulf Coast, will more than offset the possible decline in California, while in the Mississippi Valley and Rocky Mountain districts the decline will probably continue at a rate of about 10 per cent and in the Kansas-Oklahoma a much greater decline from flush pools may be expected; so that the decline for the year may reach somewhere around 100 million barrels.

Conowingo License Issued by Federal Power Commission

The Federal Power Commission on Feb. 20 issued the license covering the development of Conowingo on the Susquehanna River. Under the terms of this license the construction of this project, expected to cost $52,000,000, can be begun at once. The installation will develop 300,000 hp. The consideration of this application has occasioned unusual study and investigation on the part of the Federal Power Commission as the various contracts between the four corporations involved has made for a very complicated financing plan which requires the approval of nine separate financial instruments, it is reported.

As the Public Service Commission of Pennsylvania does not have the authority to deal with security issues, the Federal Power Commission has been called upon to pass upon the security issues of the Philadelphia Electric Power Co. Another unusual phase of this development is that the existing plant at Holtwood, Pa., furnished power for Baltimore, while the Conowingo development, which begins at the tailrace of the Holtwood plant and is in Maryland, furnishes power for Philadelphia.

New Bill Would Make Export of Quebec Power Impossible

Supplementing the promises contained in several speeches and in the address from the Throne at the opening of the present session of the Legislature, Premier Taschereau on Feb. 24 brought down his measure to prohibit the export of hydro-electric power developed in the Province of Quebec.

The bill provides that "every sale, lease or grant whatsoever of water power belonging to the province, or in which it has rights of ownership or other rights, made on or after the coming into force of this act, shall contain a clause prohibiting the exportation outside of Canada of the electric power which may be developed in this province."

It is next provided that "every contract, permit or grant authorizing from and after the same date the installation or passage of transmission lines in or over the Crown domain shall likewise contain a similar prohibitive clause."

It is also laid down that "every authorization given by the Quebec Public Service Commission under the acts concerning it shall be subordinated and subject to the prohibition enacted by the above-quoted two sections to insure enforcement."

The bill decrees that "every violation of the provisions of this act shall render null and void, at the demand of the Crown, any sale, grant or contract, any lease or permit made or granted by it," and further that "the prohibitions of the act are to apply to existing contracts unless reported to the Minister of Lands and Forests within three months after the coming into force of this act and to any renewal of such contracts at the expiration of the term for which they were made."

Contract for Another Large Frequency-Changer Set Let

There has been ordered by the Philadelphia Electric Co., one of the largest frequency-changer sets so far constructed, from the Westinghouse Electric & Manufacturing Co. This set consists of two synchronous machines with a direct-connected exciter at each end for operation at 300 r.p.m. and changing from 60 to 25 cycles. The 25-cycle generator is rated at 35,000 kva., three-phase and 21,000 kva. single phase at 13,800 volts and 85 per cent power factor. The 60-cycle motor has a rating of 41,250 hp., 45,500 kva., at 13,800 volts three-phase and 70 per cent power factor.

To minimize vibrations incident to single-phase operation, the 25-cycle generator is spring mounted. For purpose of controlling the diversion of load between this set and others that it will operate in parallel with, and to facilitate synchronizing the motor is equipped with a motor-operated frame-rotating device. The set will have an over-all length of 55 ft. and will rise 22 ft. above its foundation and will require 25 railroad cars to transport it from the factory to the power house. This contract also included eight oil circuit breakers rated at 73,000 volts and a rupturing capacity of 1,500,000 kilovolt-amperes.

Engineering Foundation Elects Officers

Re-election of Lewis Buckley Stillwell as chairman of the Engineering Foundation, research agency of the national societies of civil, mining, mechanical and electrical engineers, was announced recently following the annual meeting of the Foundation at the Engineering Societies Building, 29 West 39th St., New York City.

Mr. Stillwell, a New York engineer whose home is at Lakewood, N. J., is past president of the A.I.E.E. and the American Institute of Consulting Engineers. He is a native of Pennsylvania and a graduate of Lehigh. Wesleyan University bestowed upon him the degree of Doctor of Science.

Elmer A. Sperry, gyroscope inventor, was elected first vice-chairman to succeed Edward Dean Adams. Mr. Sperry is a member of the A.I.E.E. and A.S.M.E.

George A. Orrok was named second vice-chairman. He is a member of the A.S.M.E., A.I.M. & M.E. and the A.S.C.E.

Dean Arthur M. Greene Jr., of the Princeton School of Engineering, and J. Vipond Davies were elected to the executive committee of the foundation. Dean Greene is a member of the A.S.M.E. Mr. Davies represents the A.I.M. & M.E. and A.S.C.E.

Other officers elected were: director and secretary, Alfred D. Flinn; treasurer, Jacob S. Langthorn; assistant treasurer, Henry A. Lardner.

Plans to enlarge the endowment of the foundation will be carried out during the coming year in connection with a new policy governing the increasing cost in money and effort in the field of engineering research.

Personal Mention

H. B. Beugler has been elected a vice-president in charge of operating of the Central Hudson Gas & Electric Co.

H. A. Raitz, formerly operating engineer for the Eagle Picher Lead Co., Cincinnati, Ohio, is now chief engineer with the Ohio Mechanics Institute, Cincinnati, Ohio.

Rear Admiral Charles W. Dyson, U.S.N., retired, is now associated with the firm of J. Barraja-Frauenfelder & Co., consulting engineers, specializing in Diesel work, in the capacity of senior advisory engineer.

Harry D. Stokes, formerly power engineer with the Worcester, Mass., Electric Light Co., is now connected with the Public Service Corp. of New Jersey in the same capacity with headquarters at Newark.

Ralph Rainsford, formerly chief engineer of the Philadelphia Co., Pittsburgh, has joined the Condit Electrical Manufacturing Corp., Boston, now a subsidiary of the American Brown Boveri Co., as a consulting engineer on the executive staff.

Harry S. Schanch, merchant engineer, has dissociated himself from the Charles F. Ames & Co., as well as the Ames Pump Machinery Corp., and has established his own office at 50 Church St., New York City, to better serve his clients' pumping problems.

Col. R. E. B. Crompton, C. B., twice president of the Institution of Electrical Engineers in Great Britain, has been designated as the fifth recipient of the Faraday medal. Colonel Crompton is among the British pioneers in electrical engineering.

Harry E. Hayworth of Crawfordsville, Ind., has been appointed as superintendent of the Frankfort municipal light and power plant. Mr. Hayworth, who succeeds Charles Elkler, was previously in charge of the Crawfordsville plant for several years.

Axel Malm has recently been appointed by L. R. Meisenhalter, director of exhibits of the Sesqui-Centenniai International Exhibition, Philadelphia, Pa., to the position of chief of machinery, mining, metallurgy and transportation in charge of the main palace building No. 5.

G. G. Mills, formerly with the Riley Engineering & Supply Co., has taken over the management of the Toronto office of the Babcock-Wilcox & Goldie-McCulloch Co., the position left vacant by the recent death of William McKay. Associated with Mr. Mills in the Toronto office is **W. A. Osbourne,** formerly connected with the Chippawa development of the Hydro-Electric Power Commission of Ontario.

H. W. Eales, chief electrical engineer, Union Electric Light & Power Co., and **W. H. Sawyer,** president East St. Louis & Suburban Railway Co., both of St. Louis, sailed from San Francisco Feb. 2 for Australia. They have been appointed by the government of the State of Victoria ostensibly to "investigate and report on the Yallourn brown coal electricity-generation scheme and connected power undertakings of the Government Electricity Commission" but actually to give Australia the benefit of American experience in the development of power resources.

Walter P. Holcombe and **John C. Parker** were appointed vice-presidents of the Brooklyn Edison Co. at a meeting of the board of directors on Feb. 24. Mr. Holcombe has been purchasing agent for the company for several years. He was born in Mobile, Ala., and studied engineering at the Alabama Polytechnic Institute at Auburn. Mr. Parker has been chief electrical engineer for the company. He formerly was with the Rochester Gas & Electric Co., which he left to become a professor of electrical engineering at the University of Michigan. Early in his career he was with the General Electric Co. at Schenectady. **L. B. Bornett,** inside plant engineer, was appointed purchasing agent to succeed Mr. Holcombe. **Harry P. Woodrow,** assistant electrical engineer, was designated electrical engineer, succeeding Mr. Parker. **Edward W. Kells,** who continues as secretary of the company, becomes a director in addition, to succeed the late Charles A. Boody.

Obituary

Walter J. Santmyer, chief steam engineer of the Puget Sound Power & Light Co., died at Rochester, Minn., on the morning of Jan. 23, where he had gone expecting to be operated upon at the Mayo Brothers clinic. Mr. Santmyer was a native of West Virginia, being born in Preston County in 1856 and moving to Wheeling when he was quite a lad. At the age of 16 he went to work in the Baltimore & Ohio shops in Piedmont. He then became a fireman and three years later a locomotive engineer, a position he filled for nine years. In his capacity as an engineer, Mr. Santmyer was employed by the Havemeyer Sugar Refining Co., Curtis Bay, Md., the E. P. Allis Co. in the erection of big plants at Pittsburgh and Denver, and by Stone & Webster in Seattle, starting in 1899. He was placed in charge of the old power station on Post Street, Seattle, then the plants at Fifth Ave. and Pine St., the James Street power house and the Madison Street and Yesler Way power house. The new Post Street station was constructed under his supervision.

Society Affairs

The American Society for Testing Materials, C. L. Warwick, 1315 Spruce St., Philadelphia, will hold the spring group of meetings of its technical committees at Providence, R. I., Mar. 17-19.

The United Engineering Society, at the annual meeting of the board of trustees held Jan. 28, elected the following officers for the coming year: President, W. L. Saunders; first vice-president, Bancroft Gherardi; second vice-president, Lewis D. Rights; secretary, Alfred D. Flinn; treasurer, Jacob S. Langthorn; assistant treasurer, Henry A. Lardner.

The Baltimore Section of the A.I.E.E. will have as the attraction for its March 19 meeting, which will be held in the Engineers' Club, "Mechanical Power and Trend of Civilization," by C. E. Skinner, Westinghouse company.

The St. Louis Section of the A.I.E.E. will have a paper on the "Development of Electric Power Generation and Distribution," by Col. Peter Junkersfeld, of McClellan & Junkersfeld, as the attraction for its March 17 meeting.

The Society of Industrial Engineers, George C. Dent, 608 South Dearborn St., Chicago, Ill., will have as the main theme of its national convention which will be held at the Bellevue Stratford Hotel, Philadelphia, June 16-18, "Practical Methods for Waste Elimination."

The Association of Chemical Equipment Manufacturers, 1328 Broadway, New York City, will hold its Second Chemical Equipment and Process Engineering Exposition in Cleveland, May 10-15. The Cleveland Engineering Society and the local sections of the engineering societies will participate in the technical sessions to be held. The tentative program gives the following subjects for session: Electrochemical processes; chemical processes; beneficiation of ores; corrosion resistance; ceramics manufacture and use; design of machinery for chemical processing.

Business Notes

Kieley & Mueller, Inc., steam, water and air specialties, 34 West 13th St., New York City, announce that the firm has granted the exclusive agency for its products in Missouri to the Reeves & Skinner Machinery Co., 2211 Olive St., St. Louis, Mo.

The Superheater Co., 17 East 42d St., New York City, announces changes in the organization: M. Schiller has been elected vice-president in charge of accounts and purchases; W. F. Jetter has been elected treasurer and assistant secretary; Bard Browne has been appointed assistant to the vice-president in charge of sales and service; T. F. Morris has been appointed assistant secretary and assistant treasurer.

The Cutler-Hammer Manufacturing Co., Milwaukee, Wis., has opened a new sales office in the Healey Bldg., Atlanta, Ga., to take care of the trade in the states of North and South Carolina, the eastern section of Tennessee, Georgia, Florida, southern Alabama and Mississippi. A. C. Gibson, formerly with the Philadelphia office, is in charge. The General Machinery Co., Birmingham, Ala., will continue to serve the northern half of Alabama.

The Allis-Chalmers Manufacturing Co., Milwaukee, Wis., announces that the business of the company in Continental Europe will be handled through an organization recently incorporated as Allis-Chalmers (France) with headquarters at 3 rue Taitbout, Paris. H. I. Keen, who has been manager of the European sales through the company's district office in Paris, will be the managing director of the new organization. The company has maintained for many years an office in London at 728 Salisbury House, London Wall, P. C. 2.

Coming Conventions

American Boiler Manufacturers Association. D. W. Glanzer, 840 Rockefeller Bldg., Cleveland, Ohio. Annual convention at Homestead, Hot Springs, Va., June 1-2.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Annual convention at White Sulphur Springs, W. Va., June 21-25.

American Society for Testing Materials. C. L. Warwick, 1315 Spruce St., Philadelphia, Pa. Convention at Haddon Hall, Atlantic City, N. J., June 21-25.

American Society of Mechanical Engineers. Calvin W. Rice, 29 West 39th St., New York City. Spring convention at San Francisco, Calif., June 28-30.

American Water Works Association. W. M. Niesley, Assistant to Sec., 170 Broadway, New York City. Annual convention at Hotel Statler, Buffalo, N. Y., June 7-12.

American Welding Society. M. M. Kelly, 29 West 39th St., New York City. Annual convention at 29 West 39th St., New York City, April 21-23.

Association of Iron & Steel Electrical Engineers. John F. Kelly, 1007 Empire Bldg., Pittsburgh, Pa. Exposition and convention at Hotel Sherman, Chicago, Ill., June 7-10.

Heating & Ventilating Exposition. E. P. Frenz, Hotel McAlpin, New York City. Exposition at new Madison Square Garden, New York City, Mar. 17-23.

Master Boiler Makers Association. Harry D. Vought, 26 Cortlandt St., New York City. Annual convention at the Statler Hotel, Buffalo, N. Y., May 25-26.

National Association of Stationary Engineers. F. W. Raven, 417 South Dearborn St., Chicago, Ill. Convention at Atlantic City, begins Sept. 14. Erroneously announced as Sept. 6-11. Annual conventions and exhibitions of state association are scheduled as follows: **Indiana State Association,** F. L. Clifford, 653 South Union St., Kokomo, Ind., Convention at Lafayette, Ind., May 10-15; **New England States Association.** Freeman L. Tyler, 32 Briggs St., Taunton, Mass. Convention at New Bedford, Mass., June 16-19; **Ohio State Association,** T. S. Garrett, 2622 E. Second St., Dayton, Ohio, Convention at Newark, Ohio, June 17-19; **Connecticut State Association,** George F. Klopfer, 30 East Pearl St., New Haven, Conn., Convention at Norwich, Conn., June 25-26; **Minnesota State Association.** C. A. Nelson, 800 22nd Ave., N. E. Minneapolis, Minn. Convention at Rochester, Minn., Aug. 4-6; **New Jersey State Association,** S. G. Dalrymple, 111 Hutton St., Jersey City, Convention at Atlantic City, Sept. 12; **Pennsylvania State Association,** Frank J. McCarron, 3647 North 11th St., Philadelphia, Convention at Philadelphia, Sept. 12-13.

National Board of Boiler and Pressure Vessel Inspectors. C. O. Myers, 14 Commercial National Bank Bldg., Columbus, Ohio. National Board meeting at Chicago, Ill., May 3-5.

National District Heating Association. D. L. Gaskill, Greenville, Ohio. Convention at Niagara Hotel, Niagara Falls, June 1-4.

National Electric Light Association. A. Jackson Marshall, 29 West 39th St., New York City. Forty-ninth convention and manufacturers' exhibition, at Atlantic City, Young's Million Dollar Pier, May 17-21.

Power Show. International Textile Exposition—James F. Morgan, 53 Devonshire St., Boston, Mass. Power Show will be Department "D" of the International Textile Exposition, and will be under the auspices of the New England Association of Commercial Engineers, and held at the Mechanics Bldg., Boston, Mass., April 12-17.

Sesquicentennial International Exposition. Capt. Asher C. Baker, director in chief, Independence Square, Philadelphia. Exposition to be held in Philadelphia, Pa., from June 1 to Dec. 1.

Trade Catalogs

Preheater—The Air Preheater Corp., Wellsville, N. Y. Bulletin A-11 describes the Ljungstrom air preheater with drawings, performance charts and a table of dimensions included.

Belts—J. E. Rhoads & Sons, 35 North Sixth St., Philadelphia, Pa. "Tannate Belt" is the title of a booklet recently published by this company giving description and uses of this leather belting.

Transmission and Control—Lewellen Manufacturing Co., Columbus, Ind. Catalog No. 20, "Variable Speed Transmissions and Controlling Devices," covers applications of variable speed transmissions, together with data on performance and design. The control variable speed transmissions described in this catalog are new developments of the company.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; **mine run** except Pittsburgh gas slack:

Bituminous, Net Tons	Market Quoting	Feb. 22 1926
Pool 1	New York	$2.85@$3.25
Smokeless	Boston	2.10
Clearfield	Boston	1.85@ 2.15
Somerset	Boston	1.95@ 2.25
Kanawha	Columbus	1.40@ 1.75
Hocking	Columbus	1.35@ 1.70
Pittsburgh	Pittsburgh	2.00@ 2.10
Pittsburgh gas slack	Pittsburgh	1.00@ 1.15
Franklin, Ill.	Chicago	2.35@ 2.50
Central, Ill.	Chicago	2.00@ 2.25
Ind. 4th Vein	Chicago	2.25@ 2.35
West Ky.	Louisville	1.25@ 1.50
S. E. Ky.	Louisville	1.35@ 1.75
Big Seam	Birmingham	1.50@ 2.00
Anthracite, Gross Tons		
Buckwheat No. 1.	New York	3.00@5.50
Buckwheat No. 1.	Philadelphia	3.00@4.25
Birdseye	New York	2.00

FUEL OIL

New York—Feb. 25, light oil, tank-car lots; 28@34 deg. Baumé, 5½c. per gal.; 36@40 deg., 6½c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Feb. 16, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2.00 per bbl; 26@28 deg., $2.05 per bbl.; 28@30 deg., $2.10 per bbl.; 30@32 deg., $2.15 per bbl.; 32@36 deg., gas oil, 5.5c. per gal.; 38@40 deg., 6c. per gal.

Pittsburgh — Feb. 16, f.o.b. local refinery; 30@34 deg., fuel oil, 6c. per gal.; 36@40 deg., fuel oil, 6½c. per gal.

Dallas—Feb. 19, f.o.b. local refinery; 26@30 deg., $1.65 per bbl.

Philadelphia—Feb. 18, 27@30 deg., $2.31@$2.37 per bbl.; 18@22 deg., $1.75@$1.81; 13@19 deg., $1.68@$1.74 per bbl.

Cincinnati — Feb. 23, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 6½c. per gal.; 26@30 deg., 6¾c. per gal.; 30@32 deg., 7c. per gal.

Chicago—Feb. 23, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.30 per bbl:; 26@30 deg., $1.35; 30@32 deg., $1.55@$1.60.

New Plant Construction

Calif., Beverly Hills—City, B. J. Firminger, Clk., plans to purchase 2 multiplex type, electric, direct connected booster pumping units, complete with motors.

Calif., Los Angeles—County supervisors, will receive bids until March 15 for the construction of a saw pit dam, 165 ft. high x 540 ft. long on crest with 65 ft. bottom impounding 350 ac.ft., 2 miles north of Monrovia.

Calif., Rio Vista—City plans an election to vote $16,250 bonds for the construction of a pump house and overhauling of equipment, also plans to purchase new pump and gas engine.

Conn., Stamford—S. Zatkin, Woolsey Road, is having plans prepared for the construction of a 4 story apartment, including steam heating and electric refrigeration systems, elevators, etc. Estimated cost $600,000. D. Mansell, Strand Bldg., is architect.

Ga., Thomasville—City clerk will receive bids until March 8 for one 1250-kw. turbine and surface condenser for waterworks system. D. R. Pringle is superintendent.

Ill., Chicago—Plotke & Grosby, 111 West Washington St., plan the construction of a 25 story hotel at Wabash Ave. and Seventh St. Estimated cost $5,000,000. Architect not selected.

Ill., Chicago—Sanitary Dist., H. E. Wallace, Clk., 910 South Michigan Ave., will receive bids until March 18 for North Branch Sewage Pumping Station, Div. A. A., furnishing and installing three 75 cu.ft. per second and five 300 cu.ft. per second synchronous motor driven centrifugal pumping units.

Ill., Venice—The Illinois Power & Light Co., 1547 Illinois Merchants Bank Bldg., Chicago, has acquired 80 acres of land adjacent to its present plant and plans improvements to same, including the installation of a 30,000 kw. turbine and three 1500 hp. boilers to double the capacity here. Estimated cost $5,000,000. T. J. Lucas is chief engineer.

Ind., Muncie—Ball Memorial Hospital Board, Ball Bros., Trustees, will receive bids until March 15 for the construction of a 3 story hospital including heating plant, etc. Kibele & Garrard, are architects.

Kan., Larned—State Bd. of Administration, State House, Topeka, is receiving bids for ice and refrigeration machinery for plant here. C. D. Cuthbert, 735 Kansas St., Topeka. Former bids rejected.

Mass., Somerset—Montaup Electric Co., plans the construction of an addition to electric power plant to increase the capacity about 30,000 kw.

Mich., Detroit—Dept. of Public Works, J. W. Reid, City Hall, Comr., will receive bids until March 5 for the construction of a heating plant, including five 300 hp. boilers, boiler feed pump, air compressor, fans, stokers, coal and ash conveyors, skip hoist, etc., at Mullet and St. Antonie Sts. Donaldson & Meier, 1310 Penobscot Bldg., are architects. E. R. Little Co., 1920 Ford Bldg., is engineer.

Mich., Detroit—P. Kamper & R. L. Spitzley, Kamper Bldg., Cass Ave., awarded contract for the construction of a 15 story hotel including steam heating equipment at Woodward Ave. and Adelaide St. to Otto Misch Co., 159 East Columbus St. Estimated cost $2,500,000.

Mich., Newberry—Bd. of Education will soon award contract for the construction of a Junior and Senior high school and remodeling of power plant. Estimated cost $250,000. G. Arntzen, Escanaba, Mich., is architect.

Mich., Warren — Village voted $53,000 bonds for the construction of a waterworks system including pumping equipment, etc. George H. Ruhling & Co., 16549 Woodward Ave., Highland Park, are engineers.

Minn., Fort Snelling—U. S. Veterans' Bureau, Room 791, Arlington Bldg., Washington, D. C., awarded contract for the construction of a group of buildings, including laundry, boiler and storehouse building, etc., at U. S. Veterans' Hospital to Murth Bros. Construction Co., Railway Exchange Bldg., St. Louis, Mo. $1,377,725.

Miss., Gulfport—City, G. Odom, Street Comr., plans the construction of an additional reservoir and purchase of a large pump.

Mo., Crane—City will receive bids until March 15 for the construction of a storage reservoir and pumping equipment.

Mo., St. Louis—Bd. of Public Service will receive bids until March 16 for the installation of four 650 hp. boilers, four forced draft chain stokers, two air preheaters, coal and ash handling equipment, etc., in new waterworks at Howard's Bend. Estimated cost $105,000, $40,000, $20,000 and $68,000 respectively.

Neb., O'Neill—Armour & Co., 13th and Jones Sts., Omaha, plans the construction of a creamery and refrigeration plant here. Estimated cost $50,000. Private plans.

N. Y., Brooklyn—Brooklyn Edison Co., Pearl and Willoughby Sts., plans the construction of an electric generating plant on Ferris St. Estimated cost $2,000,000. Private plans.

N. Y., New York—Beresford Corp., B. Gordon, Pres., is having plans prepared for the construction of a 26 story apartment at 211 Central Park West. Estimated cost $3,800,000. Sugarman & Bergen, 345 Madison Ave., are architects and engineers.

N. Y., New York—New York Central R.R., 446 Lexington Ave., is having plans prepared for the construction of a 35 story office building at Park Ave. 45th to 46th Sts. Estimated cost $16,000,000. Warren & Wetmore, 10 East 47th St., are architects. G. W. Kittredge is chief engineer.

N. D., Ellendale—G. Phillip, plans the installation of additional equipment in electric light plant. Estimated cost $50,000.

O., Cleveland — Cleveland Electric Illuminating Co., R. Lindsay, Pres. and Gen. Mgr., Illuminating Bldg., awarded contract for the construction of a switch house, control house, oil storage building, etc., on Clinton Ave., to Sam W. Emerson Co., 1836 Euclid Ave. Estimated cost $150,000.

O., Columbus—Bd. of Purchases, H. C. Cain, Secy., City Hall, is in the market for three 500 kva. transformers for West Side sub-station and one 1,000 hp. water tube boiler to replace two 300 hp. boilers in light plant. Estimated cost $42,000 and $75,000 respectively.

O., Painesville — Lake Erie College for Women is having plans prepared for the construction of a dormitory, power house, etc., on Euclid Road. Estimated cost $400,000. A. Garfield, National City Bldg., Cleveland, is architect.

Okla., Comanche — City, J. P. Yates, Mayor, is in the market for a 200 hp. Diesel engine and generator for electric light plant.

Okla., Norman—City had preliminary plans prepared for the installation of a Diesel engine, motor, air compressor, etc., in waterworks plant. Estimated cost $30,000. F. Cobb is engineer.

Okla., Pond Creek — City, J. H. Asher, Mayor, is in the market for a 350 g.p.m. centrifugal pump direct connected to a 100 hp. marine type gasoline engine for waterworks plant.

Ore., Hood River—Maynard & Child, Railway Exchange Bldg., Portland, is having preliminary plans prepared for the construction of a cold storage plant here. Estimated cost $100,000.

Pa., Chester—Ford Motor Co., Highland Park, Mich., awarded contract for the construction of a group of buildings including power house, pump house, oil house, assembly building, etc., on Front St. here, to Rust Engineering Co., 311 Ross St., Pittsburgh. Estimated cost $2,000,000.

Pa., Pittsburgh—The Pittsburgh Pennsylvnaia Hotel Corp., A. W. Wyckoff, 728 Frick Bldg., plans the construction of a 21 story hotel at Seventh and Liberty Sts. Estimated cost $15,000,000. The Ballinger Co., 150 South 12th St., Philadelphia, is architect and engineer. George B. Post & Sons, 101 Park Ave., New York, N. Y., are associate architects.

Pa., Tarentum—City plans improvements to water and light plant. Estimated cost $225,000 . Hudson & Myron, 802 Wabash Bldg., Pittsburgh, are engineers.

S. C., Orangeburg—Carolina Veneer Co., Inc., is in the market for a 150 hp. boiler, 150 lbs. steam pressur.e

Tenn., Dyersburg—Dyersburg Ice & Coal Storage Co., awarded contract for the construction of an ice and cold storage plant to S. Blivins Construction Co. Machinery and equipment will be installed. Total estimated cost $100,000.

Tenn., Nashville — Montgomery Bell Academy, Harding Road, is having plans prepared for the construction of a central heating plant. Estimated cost $50,000. G. D. Waller, 201 Independent Life Bldg., is architect. School Trustees will purchase equipment.

Texas—Texas Central Power Co., Frost Bldg., San Antonio, subsidiary of the Middle West Utilities Co., 111 Broadway, New York, N. Y., has acquired ice and electric plants at Hebbronville, Goliad, Schulenburg and Cotulla and will make surveys for extensions and improvements to same. Estimated cost $100,000. Company engineers in charge. New machinery, some electrically driven, will be required.

Tex., Lubbock—Hawley & Roberts, Engrs. will soon award contract for the construction of addition to power plant, including equipment, etc., for the City. Estimated cost $30,000. F. R. Fried is mayor.

Tex., Marshall—East Texas Public Service Co., K. Lee, Gen. Mgr., subsidiary of the American Public Service Co., 72 West Adams St., Chicago, Ill., plans the installation of engines, probably electrically driven, and additional equipment in power plant here. Estimated cost $125,000. Private plans.

Tex., Pharr—M. H. Lowrie & D. McClenton will soon receive bids for the construction of a cold storage plant. Estimated cost $25,000. Private plans.

Tex., Pharr—Pharr Gin & Warehouse Co., plans the construction of two complete cotton gin plants, one at Bill Schultz switch, 8 miles south of here and one at the San Juan plantation, just south of San Juan. Total estimated cost $75,000. Oil engines will be required. A. C. Howard, in charge of construction.

Vt., Marshfield—Green Mountain Power Co. awarded contract for the construction of a power house and dam, 1,200 ft. long and 50 ft. high for hydro electric development to The Sanders Engineering Co., Portland, Me. Estimated cost $600,000. C. T. Main, c/o owner, is consulting engineer.

Wis., Madison—State Bd. of Control, State Capitol, A. Peabody, Engr., is in the market for refrigeration machinery and equipment for state prison at Waupun.

Wis., Milwaukee—Dept. of Public Works, R. Stoelting, Comr., will receive bids until March 11, for furnishing and erecting a 25,000,000 gal. vertical triple expansion crank and flywheel pumping engine in Riverside pumping station.

Wis., Milwaukee—C. T. Gross, 3020 State St., is having plans prepared for the construction of a factory at Poplar and Fourth Sts. Estimated cost $60,000. Private plans. Refrigeration and other special machinery will be required.

Wis., Plymouth—Central Steam Heat & Power Co., c/o E. E. Dillon, 316 First Central Bank Bldg., Madison, Engr., has been granted a franchise to construct a central heating plant and distribution system here. Estimated cost $155,000.

Ont., Belle River—Village, M. Forget, Clk., will receive bids until March 8 for the construction of a waterworks system including pump house, centrifugal electric pumps, elevated steel tank, etc. Estimated cost $40,000. A. W. Connor & Co., Metropolitan Bldg., Toronto, are engineers.

Ont., London—J. M. Moore, 489 Richmond St., Archts., will receive bids until March 10 for the construction of a 4 story office building, including special hot water heating system, for London Life Insurance Co., 424 Wellington St. Estimated cost $1,000,000.

Ont., Parry Sound—The McGuire-Robinson Radium & By-Products Ltd., H. F. McGuire, Purch. Agt., is in the market for a 25 hp. boiler, pump, etc.

Quebec — International Paper Co., 100 East 42nd St., New York, N. Y., plans hydro electric development at Farmers Falls on the Ottawa River. Estimated cost $1,000,000. A. H. White, c/o owner, is engineer.